Docket No. 218290US2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: Kouichi OHTAKA, et al.

SERIAL NO: 10/050,865 GAU: 2872

FILED: January 18, 2002 EXAMINER:

FOR: OPTICAL MODULATOR, OPTICAL MODULATOR MANUFACTURING METHOD, LIGHT INFORMATION PROCESSING APPARATUS INCLUDING OPTICAL MODULATOR, IMAGE FORMATION APPARATUS INCLUDING OPTICAL MODULATOR, AND IMAGE PROJECTION AND DISPLAY APPARATUS INCLUDING OPTICAL MODULATOR

INFORMATION DISCLOSURE STATEMENT UNDER 37 CFR 1.97

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

Applicant(s) wish to disclose the following information.

REFERENCES

☐ The applicant(s) wish to make of record the references listed on the attached form PTO-1449. Copies of the listed references are attached, where required, as are either statements of relevancy or any readily available English translations of pertinent portions of any non-English language references.

☐ A check is attached in the amount required under 37 CFR §1.17(p).

RELATED CASES

■ Attached is a list of applicant's pending application(s) or issued patent(s) which may be related to the present application. A copy of the claims and drawings of the pending applications are attached.

☐ A check is attached in the amount required under 37 CFR §1.17(p).

CERTIFICATION

☐ Each item of information contained in this information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

☐ No item of information contained in this information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the knowledge of the undersigned, having made reasonable inquiry, was known to any individual designated in 37 CFR §1.56(c) more than three months prior to the filing of this statement.

DEPOSIT ACCOUNT

■ Please charge any additional fees for the papers being filed herewith and for which no check is enclosed herewith, or credit any overpayment to deposit account number 15-0030. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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LIST OF RELATED CASES

Docket Number	Serial or Patent Number	Filing or Issue Date	Inventor/ Applicant
218290US2*	10/050,865	01/18/02	OHTAKA et al.
232796US2	10/394,025	03/24/03	SAKAI et al.

*Present Application; listed for information

GJM/sb

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LIST OF RELATED CASES

Docket Number	Serial or Patent Number	Filing or Issue Date	Inventor/ Applicant
218290US2*	10/050,865	01/18/02	OHTAKA et al.
232793US2	10/385,535	03/12/03	MIYAGUCHI et al.

*Present Application; listed for information

GJM/sb

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WHAT IS CLAIMED IS:

1. A developing device, comprising:

a transporting member arranged opposite to a latent image supporter and configured to develop a latent image on the latent image supporter with a powder while moving the powder;

said transporting member comprising

a plurality of electrodes configured to generate a traveling-wave electric field to move the powder,

wherein n-phase voltages are applied to the plurality of electrodes of the transporting member to form an electric field such that the powder moves towards the latent image supporter at an image portion of the latent image and the powder moves in a direction opposite to the latent image supporter at a non-image portion of the latent image.

2. The developing device of claim 1, wherein an average potential of the n-phase voltages applied to the plurality of electrodes of the transporting member is set to a potential between a potential of the image portion of the latent image and a potential of the non-image portion of the latent image.

3. The developing device of claim 1, wherein the n-phase voltages applied to the electrodes of the transporting member have a waveform such that a pulse voltage and a DC bias voltage are overlapped.

4. The developing device of claim 3, further comprising:

means for outputting the DC bias voltage, wherein the means is able to vary the DC bias voltage.

5. The developing device of claim 1, wherein the n-phase voltages applied to the plurality of electrodes of the transporting member are pulse-shaped waveforms.

6. The developing device of claim 1, wherein the n-phase voltages applied to the plurality of electrodes of the transporting member have a pulse-shaped waveform, and wherein a potential of the pulse-shaped waveform that causes the powder to repulsively fly is a potential between a potential of the image portion of the latent image and a potential of the non-image portion of the latent image.

7. A developing device, which develops a latent image on a latent image supporter with a powder while moving the powder, comprising:

a means for generating an electric field in a direction so that the powder moves in a direction opposite to the latent image supporter at a region after a developing region.

8. A developing device, which develops a latent image on a latent image supporter with a powder while moving the powder, comprising:

a means for generating a first electric field such that the powder at an image portion of the latent image moves towards the latent image supporter and the powder at a non-image portion of the latent image move in a direction opposite to the latent image supporter, and for generating a second electric field such that the powder present at a region after a developing region moves in a direction opposite to the latent image supporter.

9. The developing device of claim 7, wherein a strength of the electric field formed at the region after the developing region is set within a range so that the powder adhered on the latent image supporter is not separated from a surface of the latent image supporter.

10. The developing device of claim 8, wherein a strength of the electric field formed at the region after the developing region is set within a range so that the powder adhered on the latent image supporter is not separated from a surface of the latent image supporter.

11. The developing device of claim 7, wherein the means for generating an electric

field comprises a transporting member, wherein the transporting member comprises a plurality of electrodes for generating a traveling-wave electric field to transport the powder, and wherein n-phase voltages are applied to each of the plurality of electrodes of the transporting member.

12. The developing device of claim 8, wherein the means for generating an electric field comprises a transporting member, wherein the transporting member comprises a plurality of electrodes for generating a traveling-wave electric field to transport the powder, and wherein n-phase voltages are applied to each of the plurality of electrodes of the transporting member.

13. The developing device of claims 11, wherein the n-phase voltages are applied to the transfer member such that in the developing region an electric field in a direction where the powder moves towards the latent image supporter is formed at the image portion of the latent image but moves in a direction opposite to the latent image supporter at the non-image portion of the latent image, and an electric field in a direction where the powder moves in a direction opposite to the latent image supporter is formed in the region after the developing region.

14. The developing device of claims 12, wherein the n-phase voltages are applied to the transfer member such that in the developing region an electric field in a direction where the powder moves towards the latent image supporter is formed at the image portion of the latent image but moves in a direction opposite to the latent image supporter at the non-image portion of the latent image, and an electric field in a direction where the powder moves in a direction opposite to the latent image supporter is formed in the region after the developing region.

15. The developing device of claim 11, wherein at the developing region, an average

potential of the n-phase voltages applied to the transporting member is set to a potential between a potential of the image portion of the latent image and a potential of the non-image portion of the latent image, and wherein at the region after the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential higher than the potentials of the image portion and the non-image portion.

16. The developing device of claim 12, wherein at the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential between a potential of the image portion of the latent image and a potential of the non-image portion of the latent image, and wherein at the region after the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential higher than the potentials of the image portion and the non-image portion.

17. The developing device of claim 11, wherein at the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential between a potential of the image portion of the latent image and a potential of the non-image portion of the latent image, and wherein at the region after the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential lower than the potentials of the image portion and the non-image portion.

18. The developing device of claim 12, wherein at the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential between a potential of the image portion of the latent image and a potential of the non-image portion of the latent image, and wherein at the region after the developing region, an average potential of the n-phase voltages applied to the transporting member is set to a potential lower than the potentials of the image portion and the non-image portion.

19. The developing device of claim 11, wherein different bias voltages are further

applied to the transporting member depending on a gap between the latent image supporter and the transporting member.

20. The developing device of claim 12, wherein different bias voltages are further applied to the transporting member depending on a gap between the latent image supporter and the transporting member.

21. The developing device of claim 11, wherein the n-phase voltages applied to the transporting member are changed depending on a gap between the latent image supporter and the transporting member.

22. The developing device of claim 12, wherein the n-phase voltages applied to the transporting member are changed depending on a gap between the latent image supporter and the transporting member.

23. The developing device of claim 11, wherein a gap between the latent image supporter and the transporting member at the developing region is substantially the same as a gap between the latent image supporter and the transporting member at the region after the developing region.

24. The developing device of claim 12, wherein a gap between the latent image supporter and the transporting member at the developing region is substantially the same as a gap between the latent image supporter and the transporting member at the region after the developing region.

25. The developing device of claim 23, wherein the transporting member comprises a bent portion.

26. The developing device of claim 24, wherein the transporting member comprises a bent portion.

27. The developing device of claim 25, wherein the bent portion of the transporting

member is formed at the region after the developing region.

28. The developing device of claim 26, wherein the bent portion of the transporting member is formed at the region after the developing region.

29. The developing device of claim 27, wherein the gap between the latent image supporter and the portion of the transporting member at the region after the developing region is getting wider in a direction opposite to the developing region.

30. The developing device of claim 28, wherein the gap between the latent image supporter and the portion of the transporting member at the region after the developing region is getting wider in a direction opposite to the developing region.

31. The developing device of claim 11, wherein the voltages applied to the electrodes are from 0V to –V1 at the developing region, and from 0V to +V2 at the region after the developing region.

32. The developing device of claim 12, wherein the voltages applied to the electrodes are from 0V to –V1 at the developing region, and from 0V to +V2 at the region after the developing region.

33. The developing device of claim 11, wherein the voltage applied to the electrodes are from 0V to +V3, and from 0V to –V4 at the region after the developing region.

34. The developing device of claim 12, wherein the voltage applied to the electrodes are from 0V to +V3, and from 0V to –V4 at the region after the developing region.

35. The developing device of claim 31, further comprising a circuit for generating the n-phase applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit.

36. The developing device of claim 32, further comprising a circuit for generating the n-phase applied to the electrode of the transporting member, wherein the circuit

comprises a clamper circuit.

37. The developing device of claim 33, further comprising a circuit for generating the n-phase applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit.

38 The developing device of claim 34, further comprising a circuit for generating the n-phase applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit.

39. The developing device of claim 11, wherein the voltages applied to the electrodes are from –V5 to –V6 (V5>V6) at the developing region, and from +V7 to +V8 (V8>V7) at the region after the developing region.

40. The developing device of claim 12, wherein the voltages applied to the electrodes are from –V5 to –V6 (V5>V6) at the developing region, and from +V7 to +V8 (V8>V7) at the region after the developing region.

41. The developing device of claim 11, wherein the voltages applied to the electrodes are from +V9 to +V10 (V10>V9) at the developing region, and from –V11 to –V12 (V11>V12) at the region after the developing region.

42 The developing device of claim 12, wherein the voltages applied to the electrodes are from +V9 to +V10 (V10>V9) at the developing region, and from –V11 to –V12 (V11>V12) at the region after the developing region.

43. The developing device of claim 39, further comprising a circuit for generating the n-phase voltages applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit, and wherein the clamper circuit comprises a means for generating a DC bias voltage.

44. The developing device of claim 40, further comprising a circuit for generating

the n-phase voltages applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit, and wherein the clamper circuit comprises a means for generating a DC bias voltage.

45. The developing device of claim 41, further comprising a circuit for generating the n-phase voltages applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit, and wherein the clamper circuit comprises a means for generating a DC bias voltage.

46. The developing device of claim 42, further comprising a circuit for generating the n-phase voltages applied to the electrode of the transporting member, wherein the circuit comprises a clamper circuit, and wherein the clamper circuit comprises a means for generating a DC bias voltage.

47. The developing device of claim 43, wherein the means for generating a DC bias voltage is able to vary the DC bias voltage.

48. The developing device of claim 44, wherein the means for generating a DC bias voltage is able to vary the DC bias voltage.

49. The developing device of claim 45, wherein the means for generating a DC bias voltage is able to vary the DC bias voltage.

50. The developing device of claim 46, wherein the means for generating a DC bias voltage is able to vary the DC bias voltage.

51. A developing method, in which a latent image on a latent image supporter is developed with a powder to form a visual image thereon, comprising:

developing the latent image with the powder at a developing region; and

forming an electric field in a direction such that the powder moves in a direction opposite to the latent image supporter at a region after a developing region.

52. A process cartridge, which is detachable from a main body of an image forming device, comprising:

a housing; and

the developing device according to claim 1.

53. A process cartridge, which is detachable from a main body of an image forming device, comprising:

a housing; and

the developing device according to claim 7.

54. A process cartridge, which is detachable from a main body of an image forming device, comprising:

a housing; and

the developing device according to claim 8.

55. An image forming device, comprising:

a latent image supporter configured to bear a latent image thereon; and

a developing device configured to develop the latent image with a powder to form a visual image on the latent image supporter,

wherein the developing device is the developing device according to claim 1.

56. An image forming device, comprising:

a latent image supporter configured to bear a latent image thereon; and

a developing device configured to develop the latent image with a powder to form a visual image on the latent image supporter,

wherein the developing device is the developing device according to claim 7.

57. An image forming device, comprising:

a latent image supporter configured to bear a latent image thereon; and

a developing device configured to develop the latent image with a powder to form a visual image on the latent image supporter,

wherein the developing device is the developing device according to claim 8.

58. An image forming device, comprising:

a latent image supporter configured to bear a latent image thereon; and

a process cartridge configured to develop the latent image with a powder to form a visual image on the latent image supporter,

wherein the process cartridge is the process cartridge according to claim 52.

59. An image forming device, comprising:

a latent image supporter configured to bear a latent image thereon; and

a process cartridge configured to develop the latent image with a powder to form a visual image on the latent image supporter,

wherein the process cartridge is the process cartridge according to claim 53.

60. An image forming device, comprising:

a latent image supporter configured to bear a latent image thereon; and

a process cartridge configured to develop the latent image with a powder to form a visual image on the latent image supporter,

wherein the process cartridge is the process cartridge according to claim 54.

61. An image forming device for forming a color image, comprising:

at least one latent image supporter configured to bear a latent image thereon; and a plurality of process cartridges each configured to develop the latent image with a powder to form a visual image on the image supporter, wherein each of the plurality of process cartridges is the process cartridge according to claim 52.

62. An image forming device for forming a color image, comprising:

at least one latent image supporter configured to bear a latent image thereon; and a plurality of process cartridges each configured to develop the latent image with a powder to form a visual image on the image supporter, wherein each of the plurality of process cartridges is the process cartridge according to claim 53.

63. An image forming device for forming a color image, comprising:

at least one latent image supporter configured to bear a latent image thereon; and a plurality of process cartridges each configured to develop the latent image with a powder to form a visual image on the image supporter, wherein each of the plurality of process cartridges is the process cartridge according to claim 54.

64. An image forming method, comprising:

forming a latent image on a latent image supporter;

developing the latent image with a powder at a developing region; and

forming an electric field in a direction such that the powder moves in a direction opposite to the latent image supporter at a region after the developing region.

ABSTRACT OF THE INVENTION

A developing device is provided. The developing device comprises a latent image supporter, wherein powder is adhered on the latent image supporter to develop a latent image on the latent image supporter; a transporting member arranged opposite to the latent image supporter; and a plurality of electrodes formed in the transporting member for generating a traveling-wave electric field to move the powder, wherein n-phase voltages are applied to the electrodes of the transporting member to form an electric field in a first direction so that the powder moves towards the latent image supporter at an image portion of the latent image and in a second direction so that the powder moves in a direction opposite to the latent image supporter at a non-image portion of the latent image.

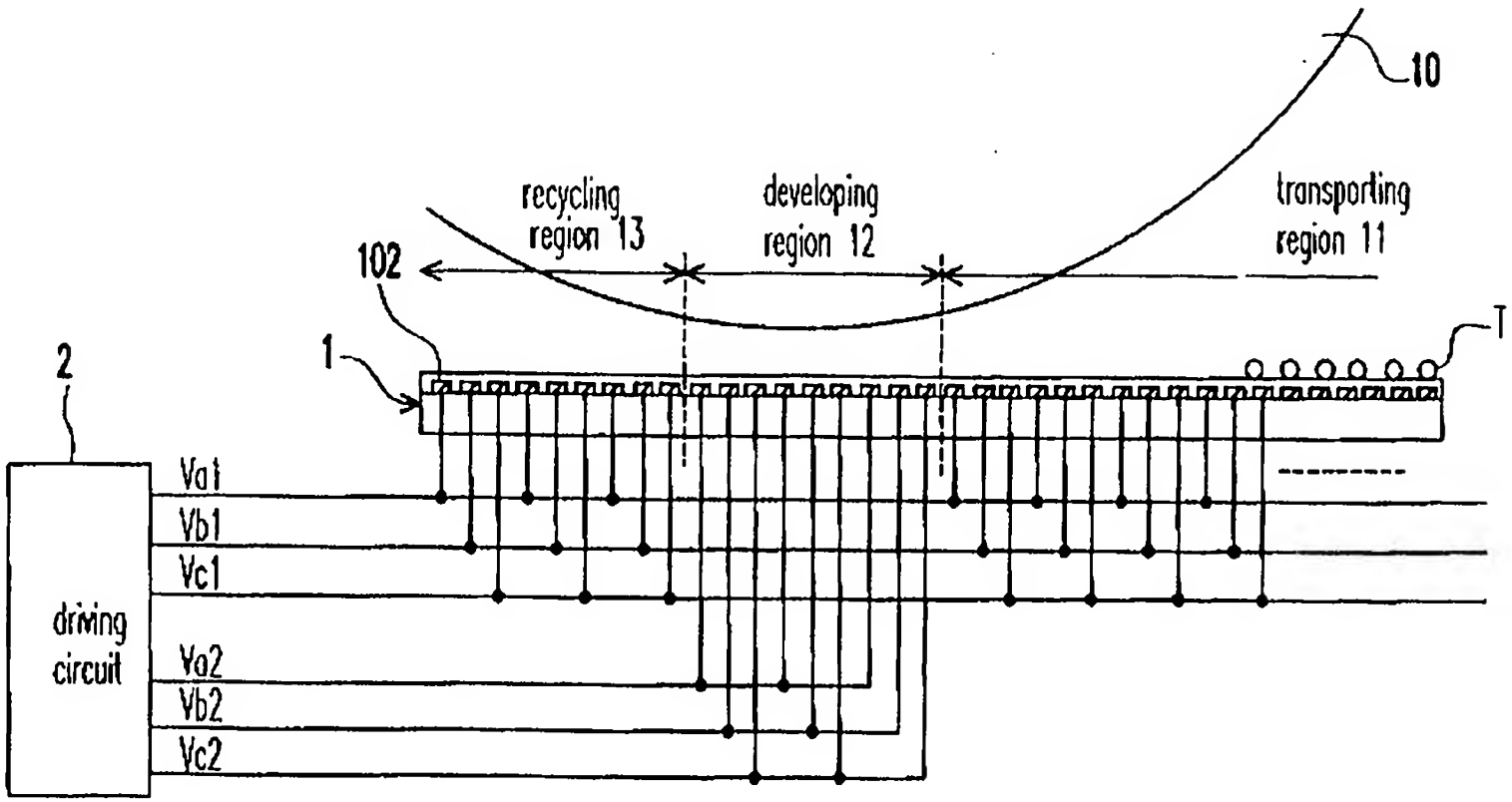

10
recycling region 13
developing region 12
transporting region 11
102
1
2
T
Va1
Vb1
Vc1
driving circuit
Va2
Vb2
Vc2

FIG. 1

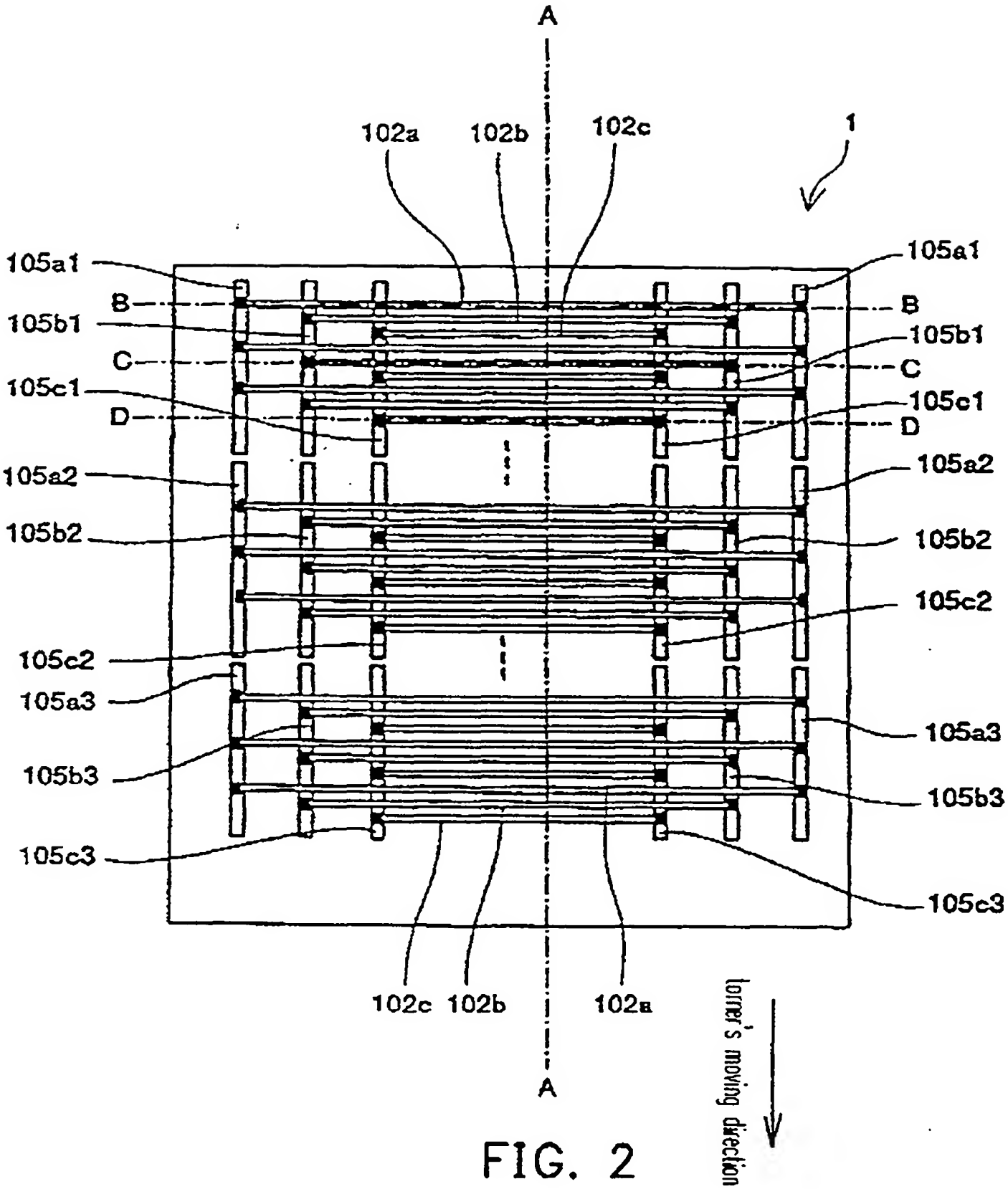

A
102a
102b
102c
1
105a1
B
105b1
C
105c1
D
105a2
105b2
105c2
105a3
105b3
105c3
102c
102b
102B
A
Torrer's moving direction

FIG. 2

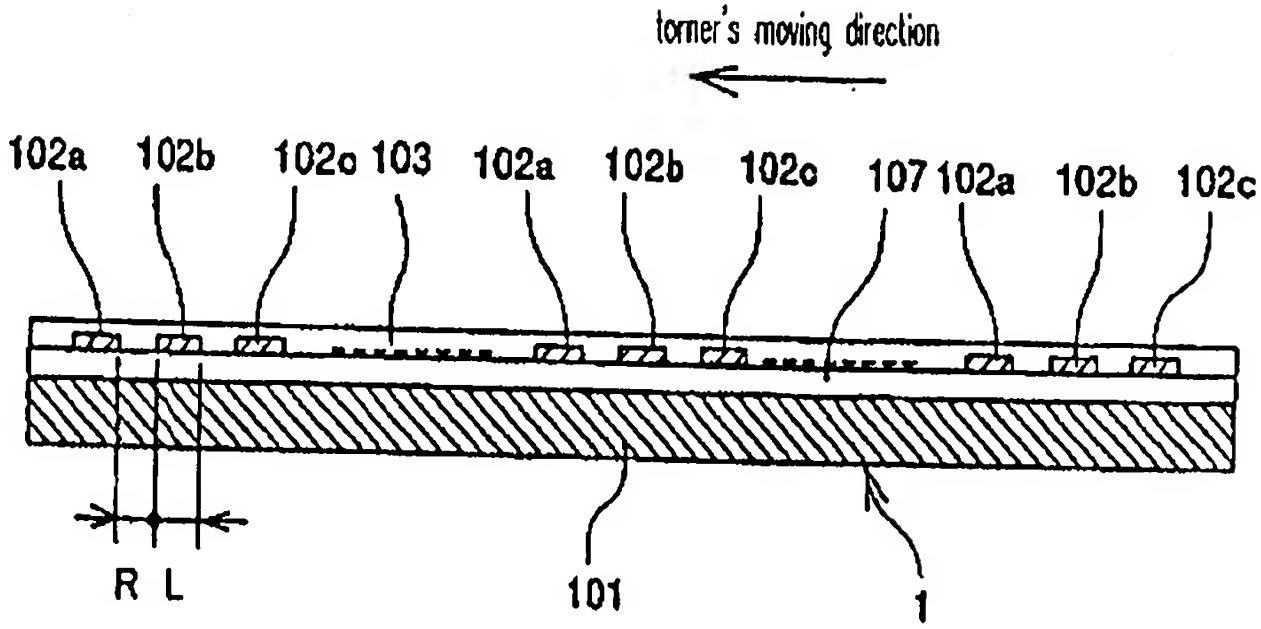

toner's moving direction
102a
102b
102c
103
102a
102b
102c
107
102a
102b
102c
R L
101
1

FIG. 3

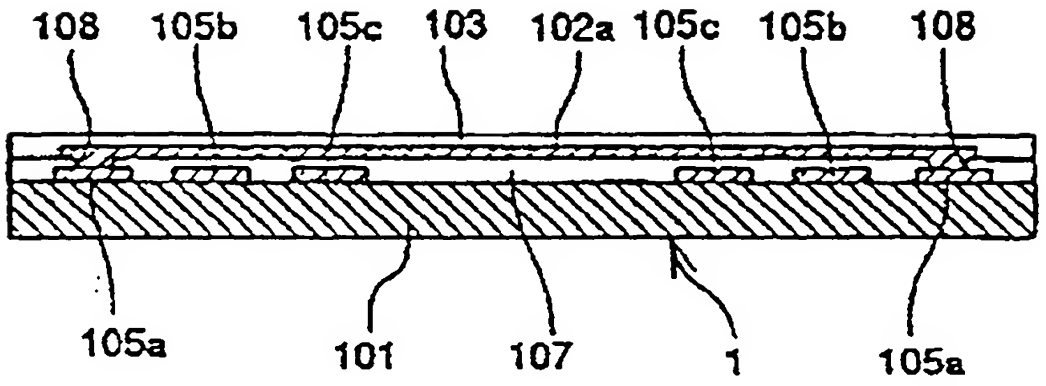


FIG. 4

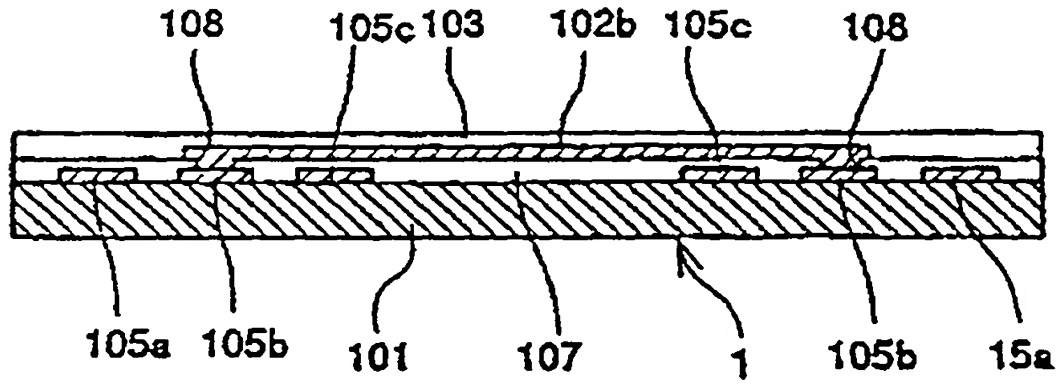


FIG. 5

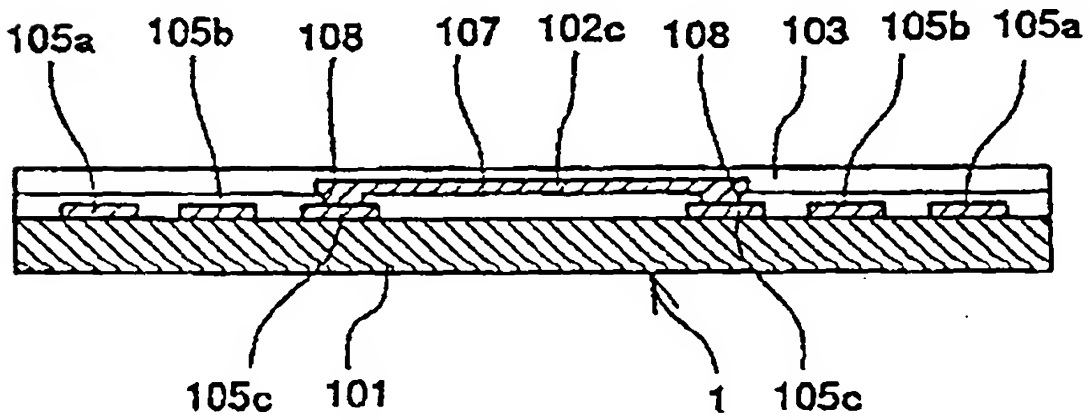


FIG. 6

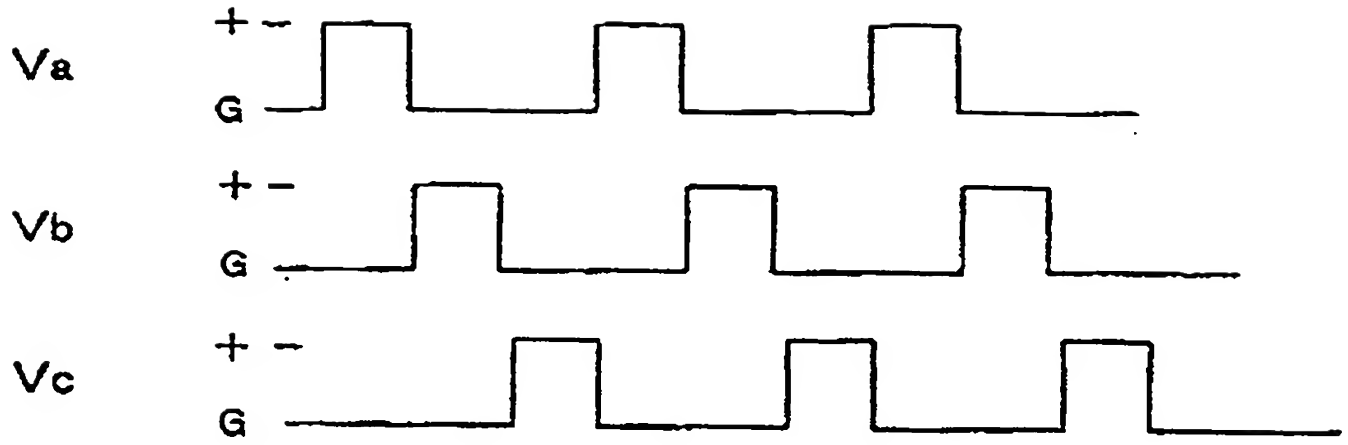


FIG. 7

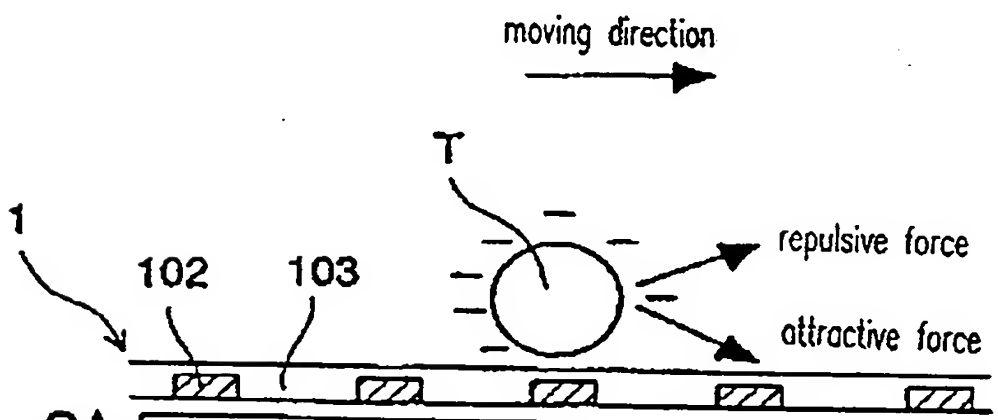


FIG. 8A

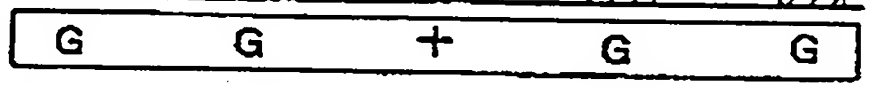


FIG. 8B

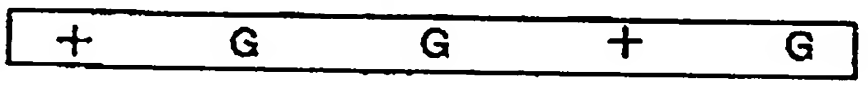


FIG. 8C

FIG. 9A

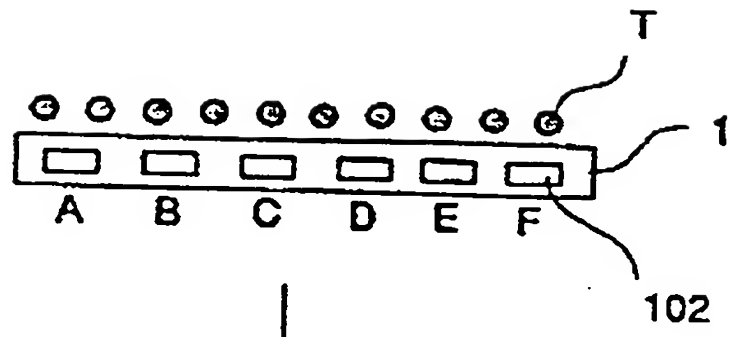


FIG. 9B

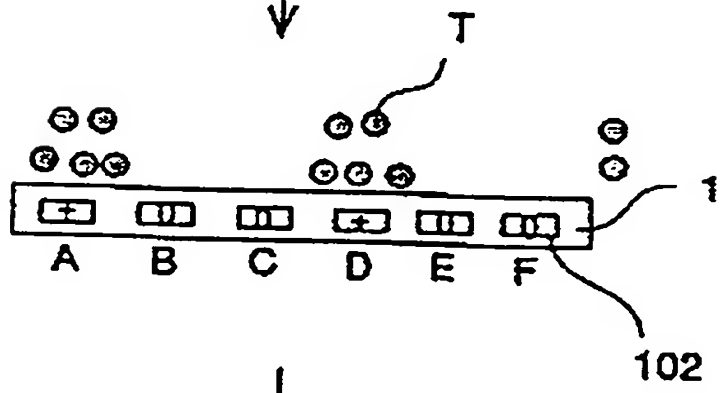


FIG. 9C

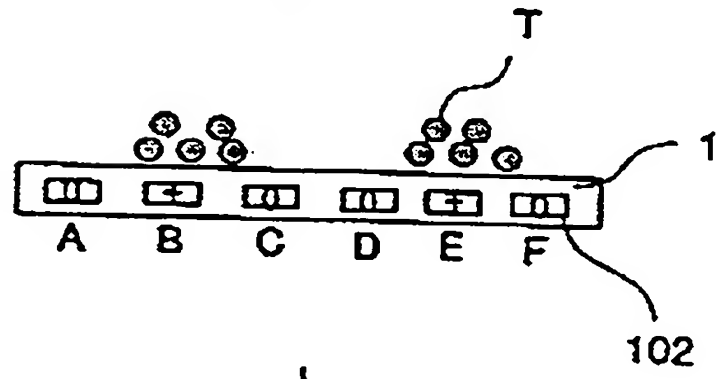
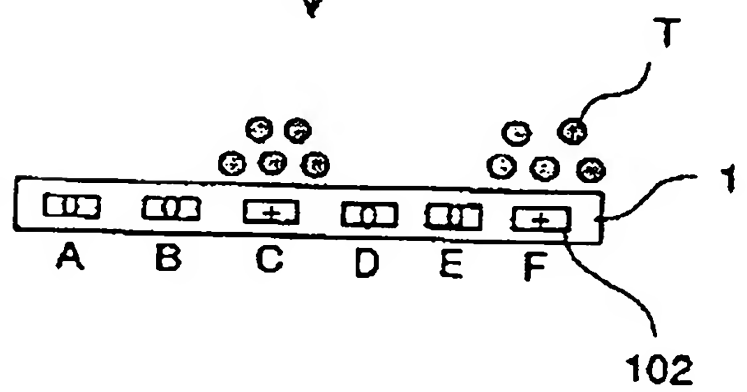


FIG. 9D



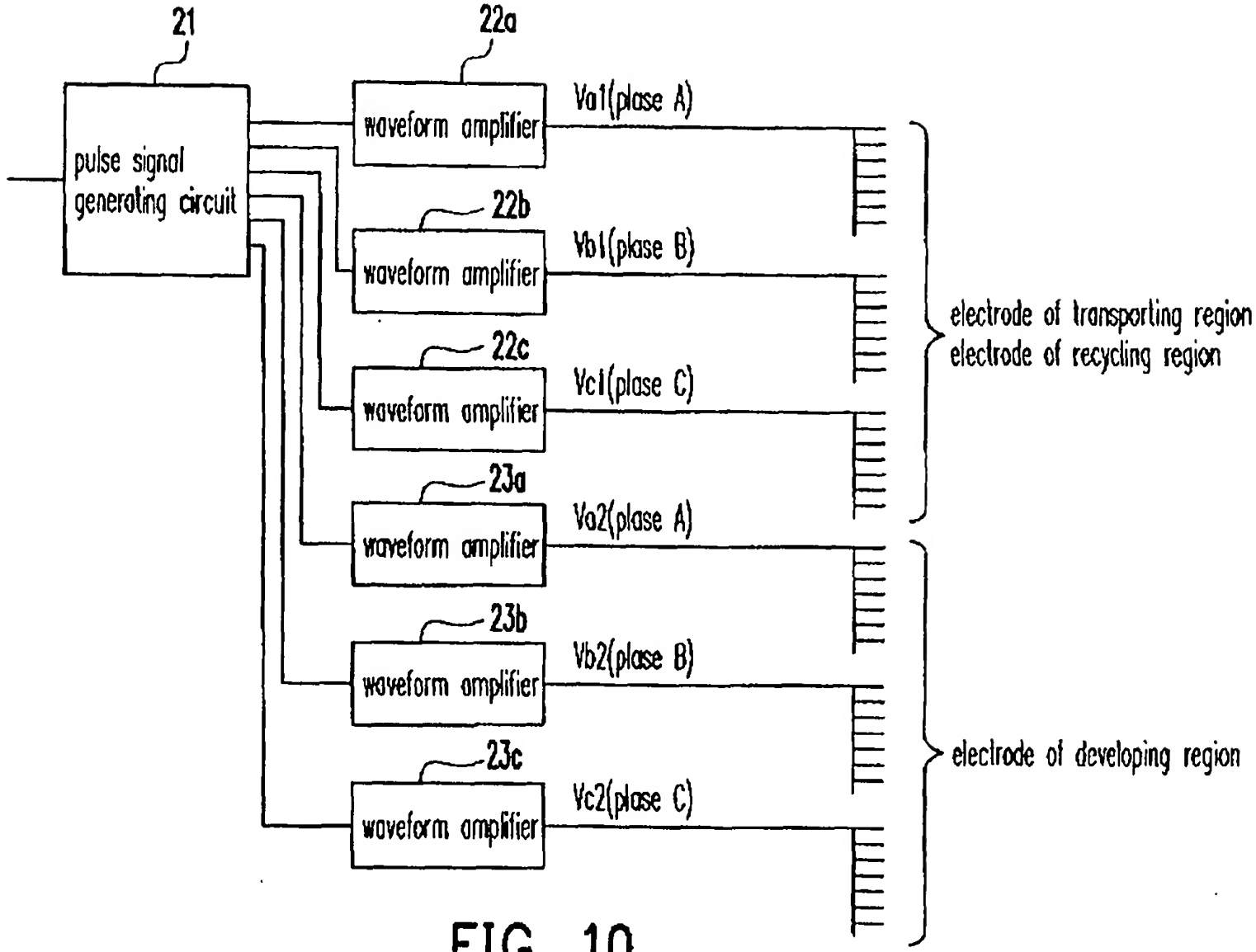

21
22a
pulse signal generating circuit
waveform amplifier
Va1(plase A)
22b
waveform amplifier
Vb1(plase B)
22c
waveform amplifier
Vc1(plase C)
electrode of transporting region
electrode of recycling region
23a
waveform amplifier
Va2(plase A)
23b
waveform amplifier
Vb2(plase B)
23c
waveform amplifier
Vc2(plase C)
electrode of developing region

FIG. 10

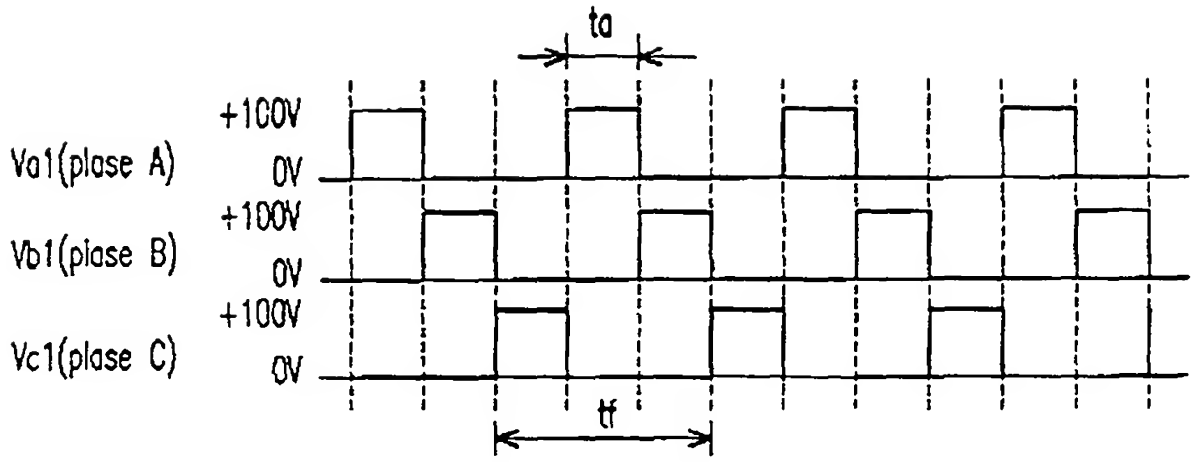


FIG. 11

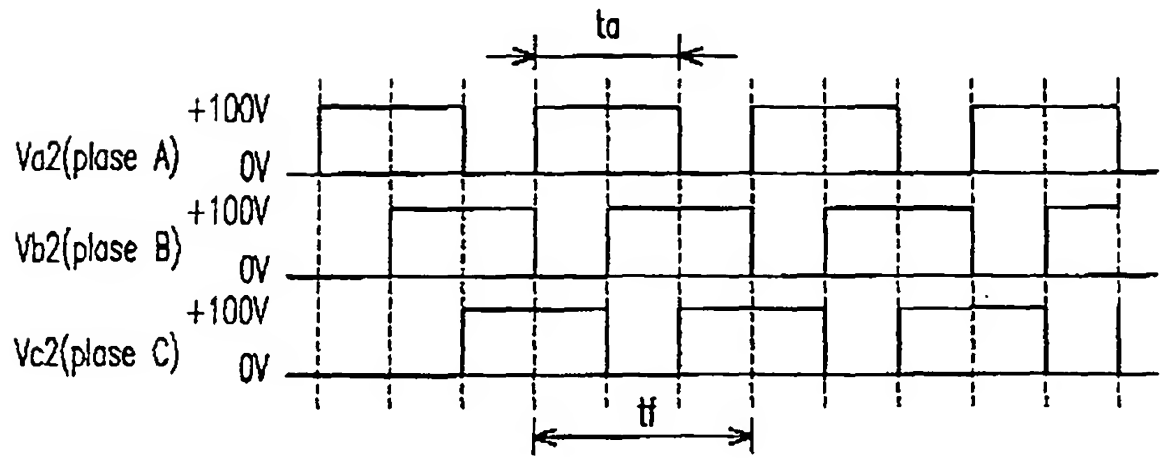


FIG. 12

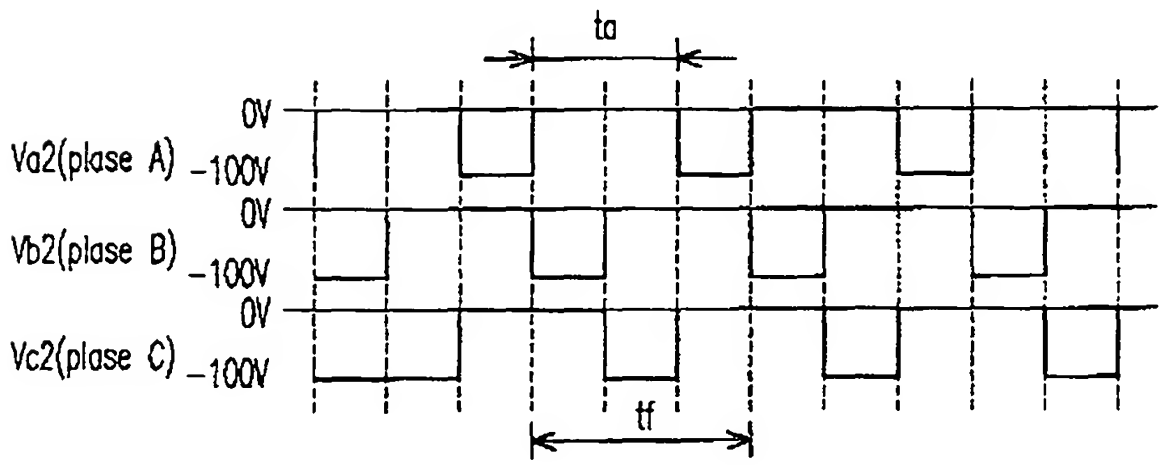


FIG. 13

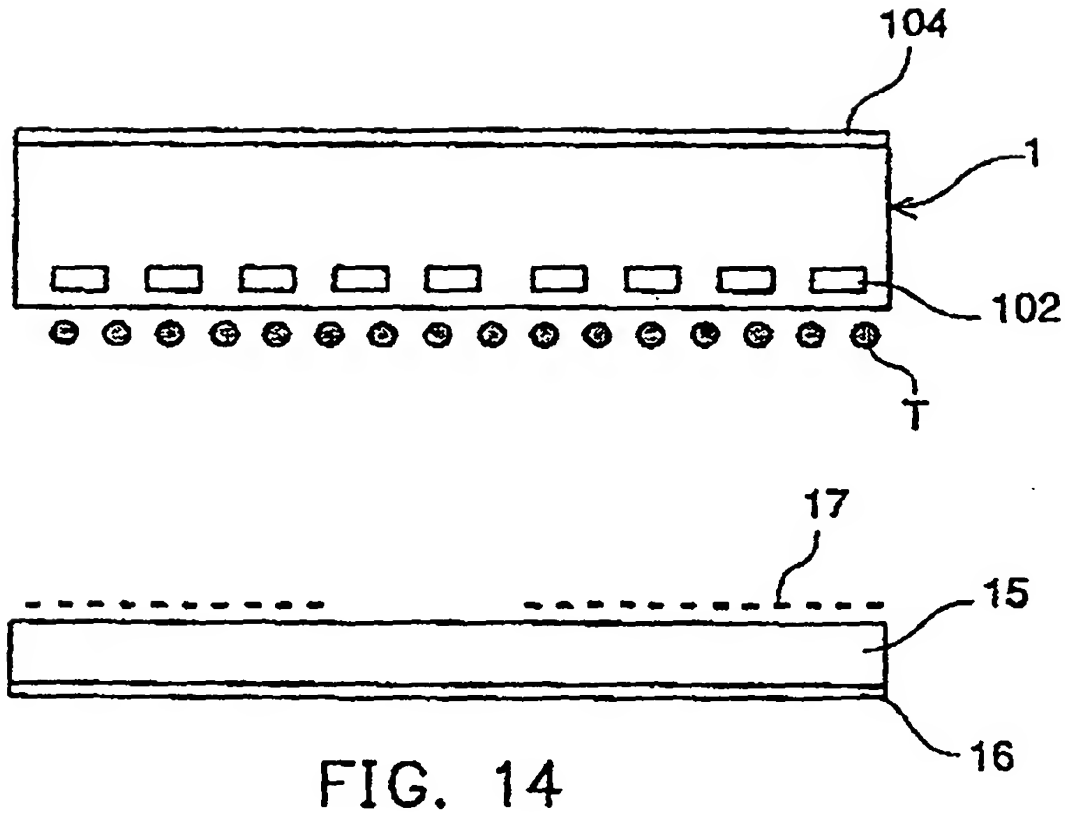


FIG. 14

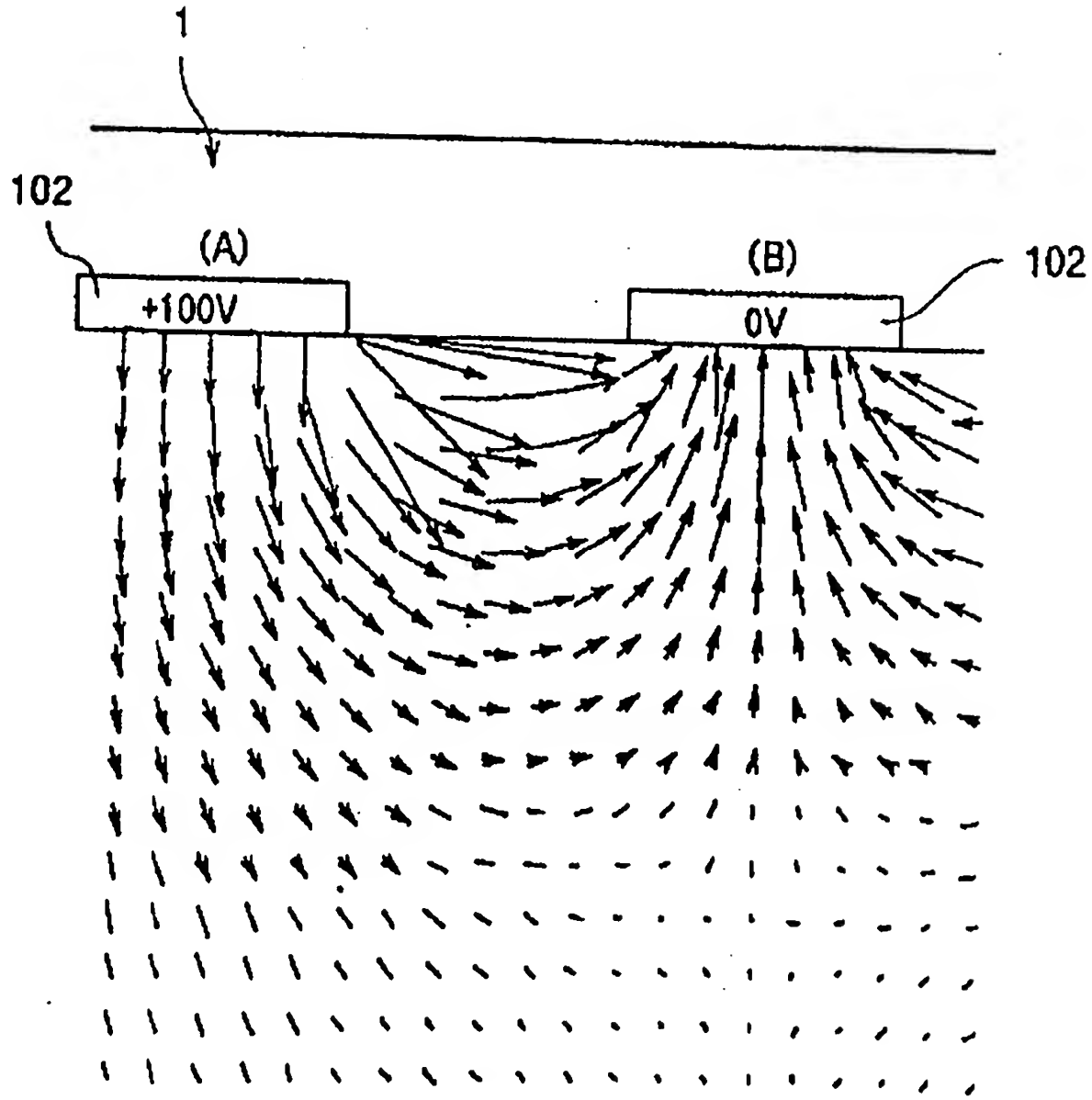


FIG. 15

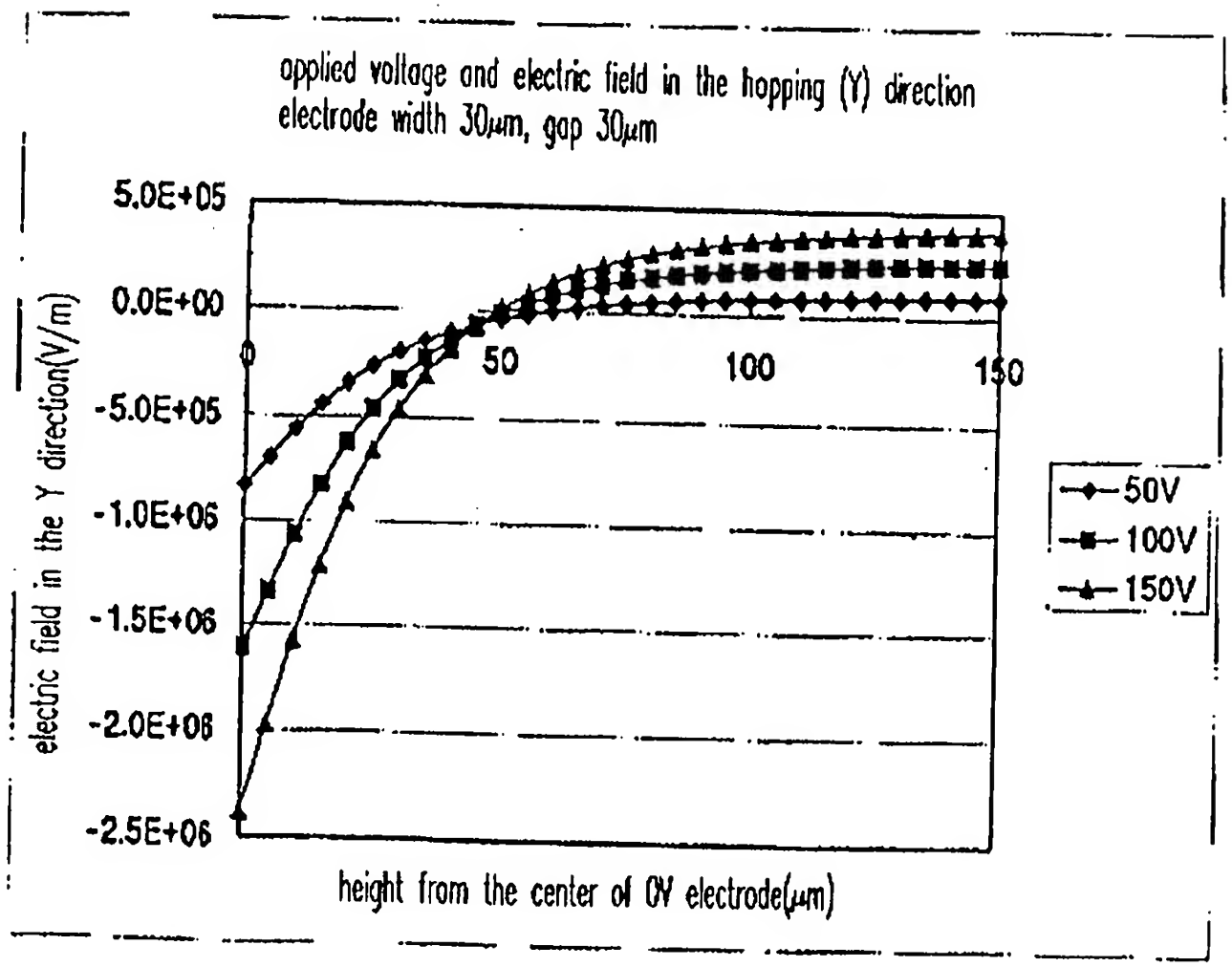

applied voltage and electric field in the hopping (Y) direction
electrode width 30μm, gap 30μm
5.0E+05
0.0E+00
-5.0E+05
-1.0E+06
-1.5E+06
-2.0E+06
-2.5E+06
electric field in the Y direction(V/m)
0
50
100
150
height from the center of 0V electrode(μm)
50V
100V
150V

FIG. 16

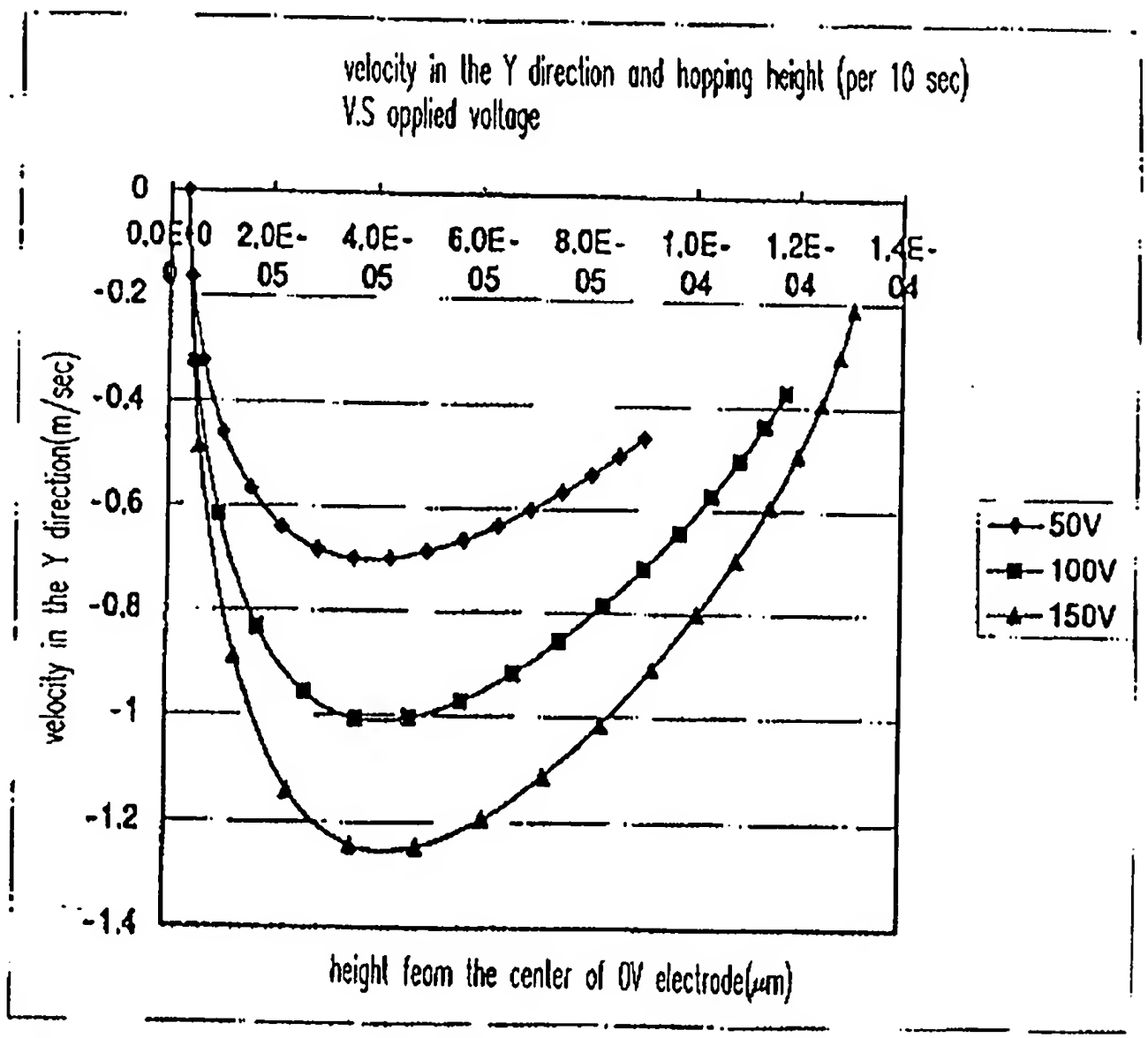
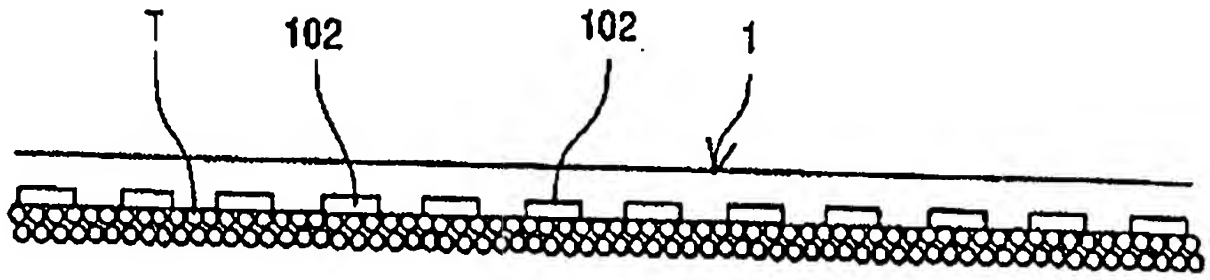

velocity in the Y direction and hopping height (per 10 sec)
V.S applied voltage
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0.0E-0
2.0E-05
4.0E-05
6.0E-05
8.0E-05
1.0E-04
1.2E-04
1.4E-04
velocity in the Y direction(m/sec)
height feom the center of 0V electrode(μm)
50V
100V
150V

FIG. 17



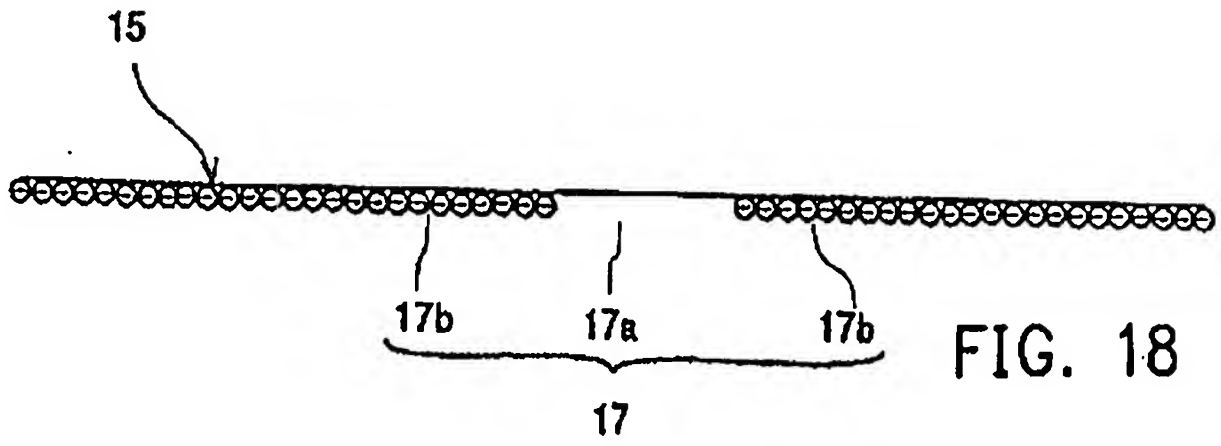


FIG. 18

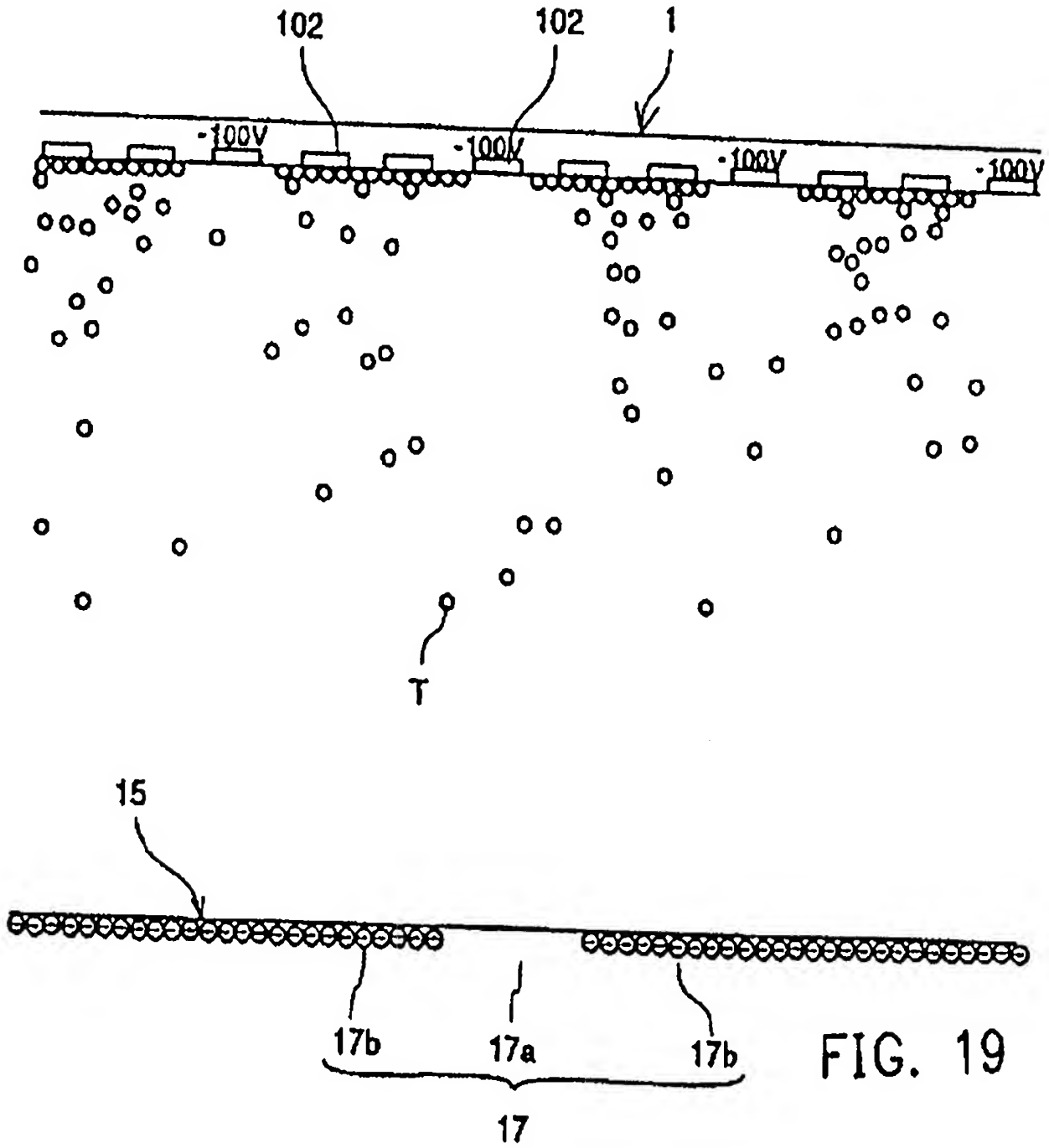


FIG. 19

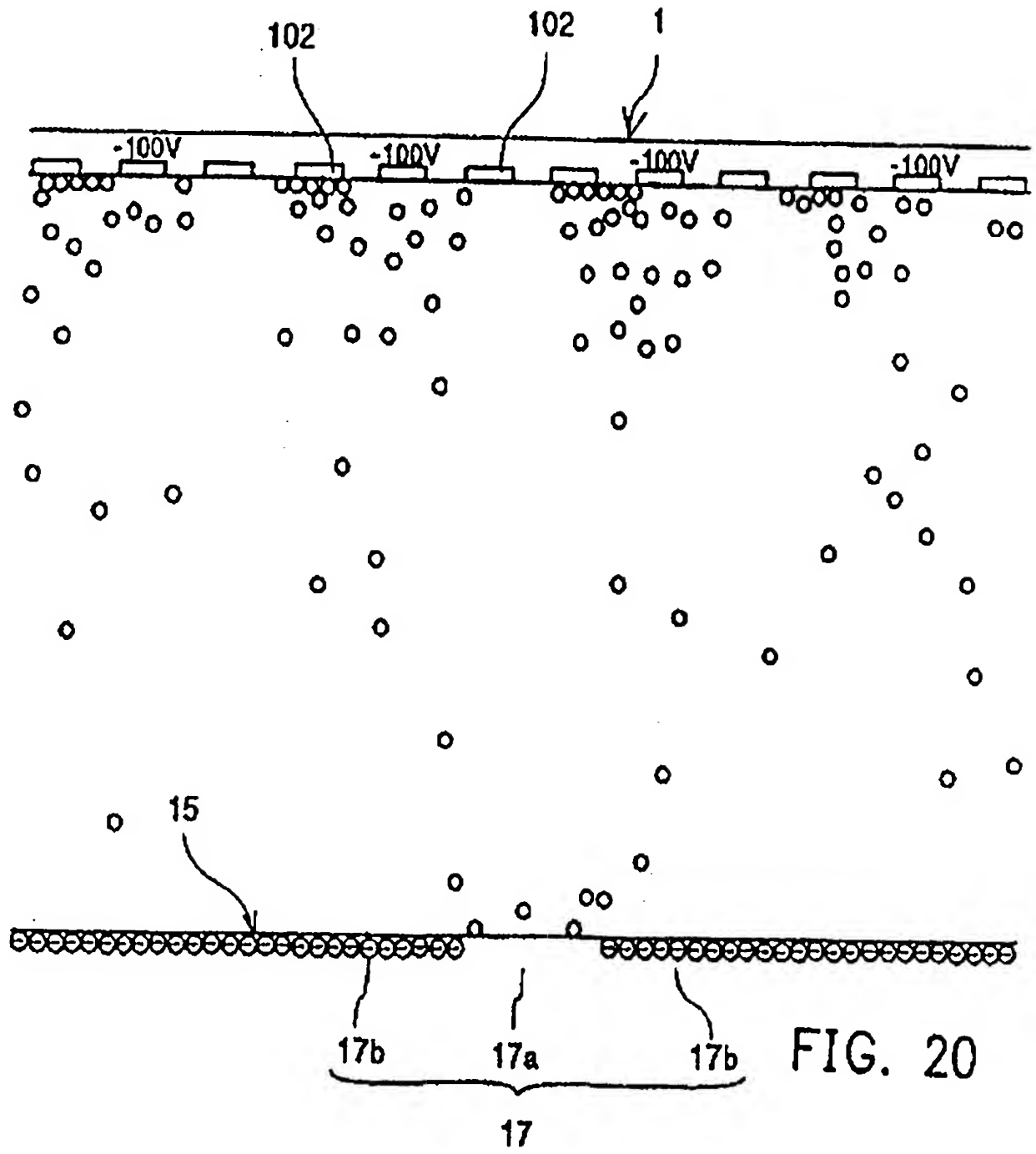


FIG. 20

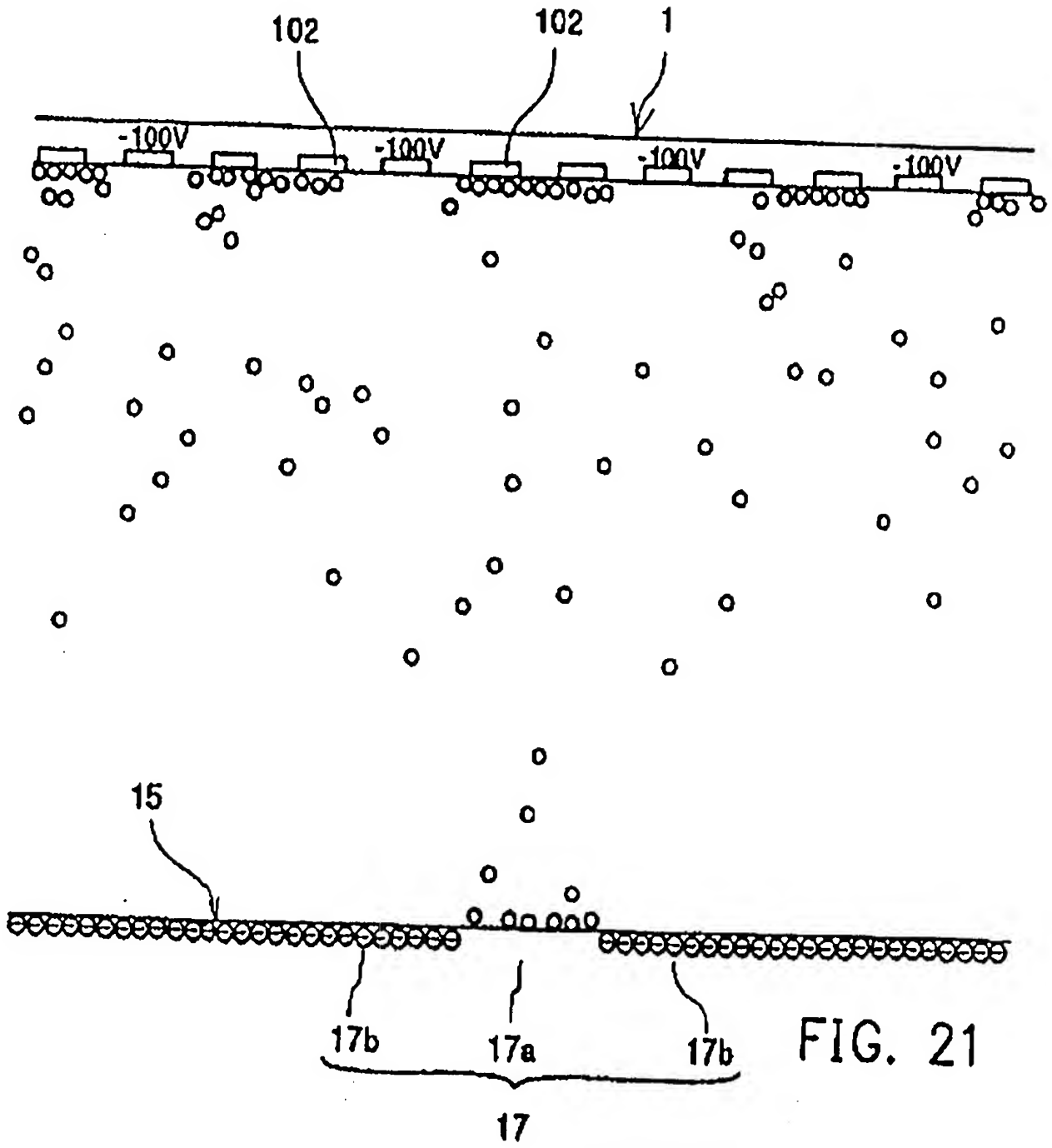


FIG. 21

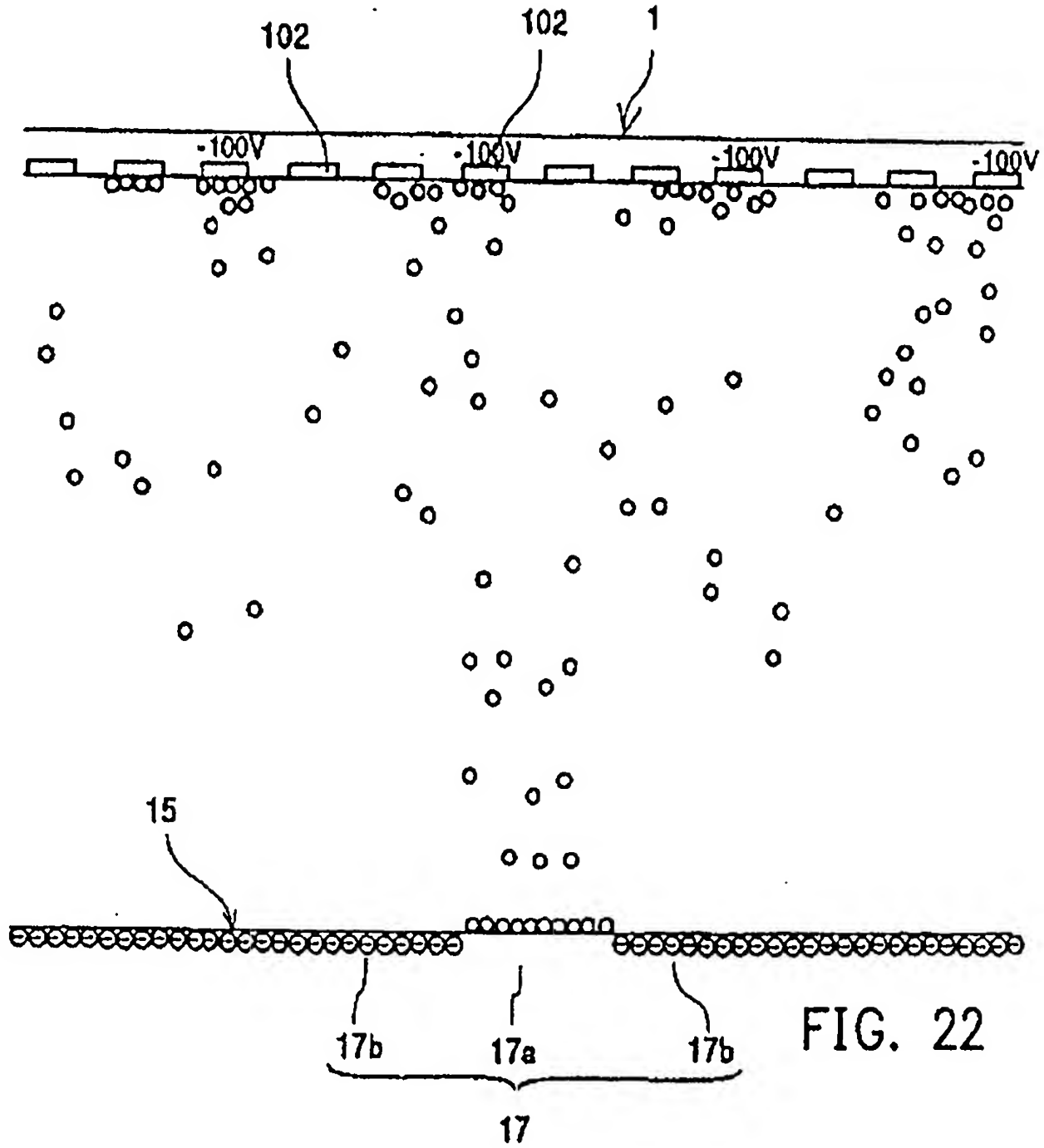


FIG. 22

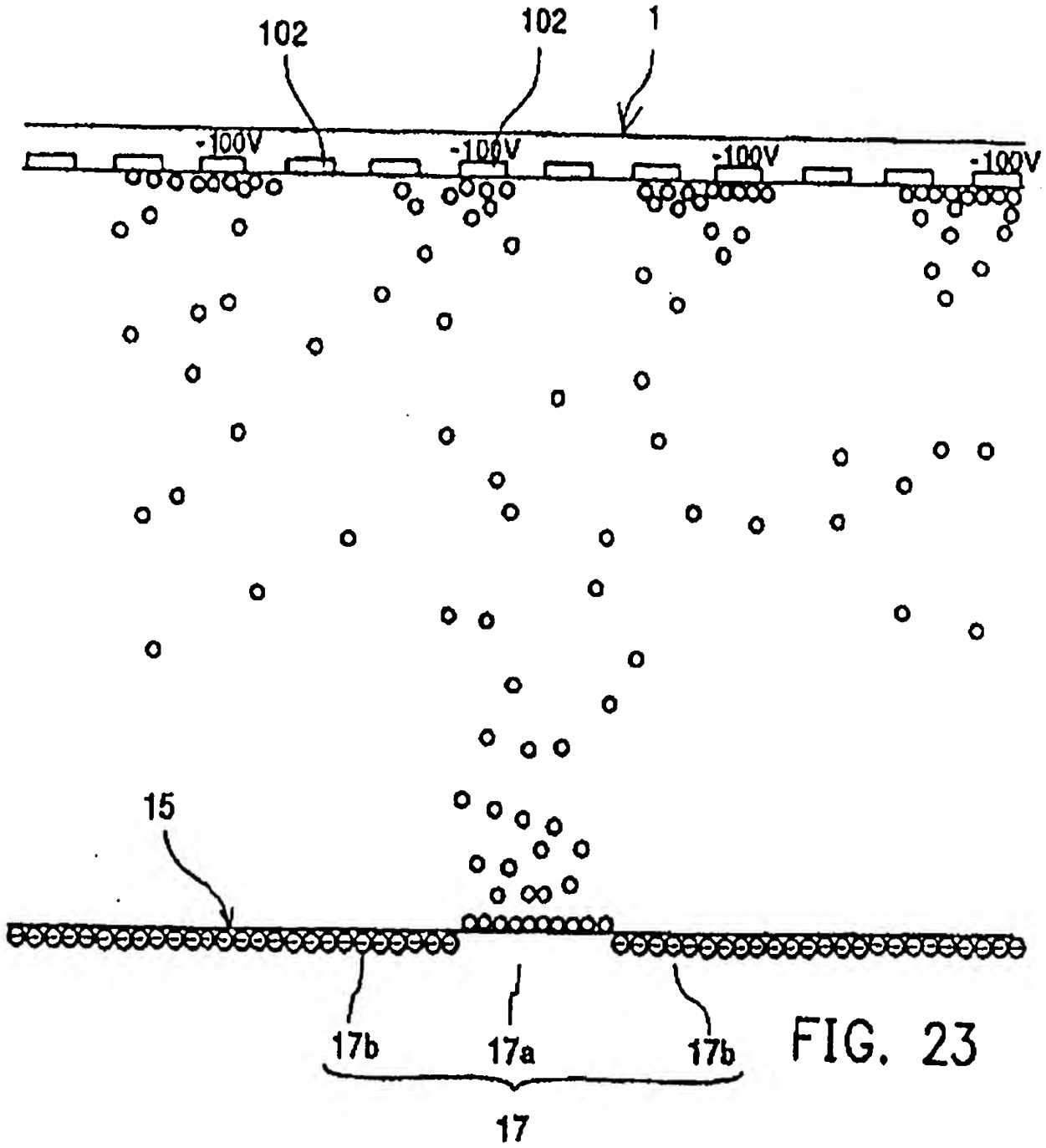


FIG. 23

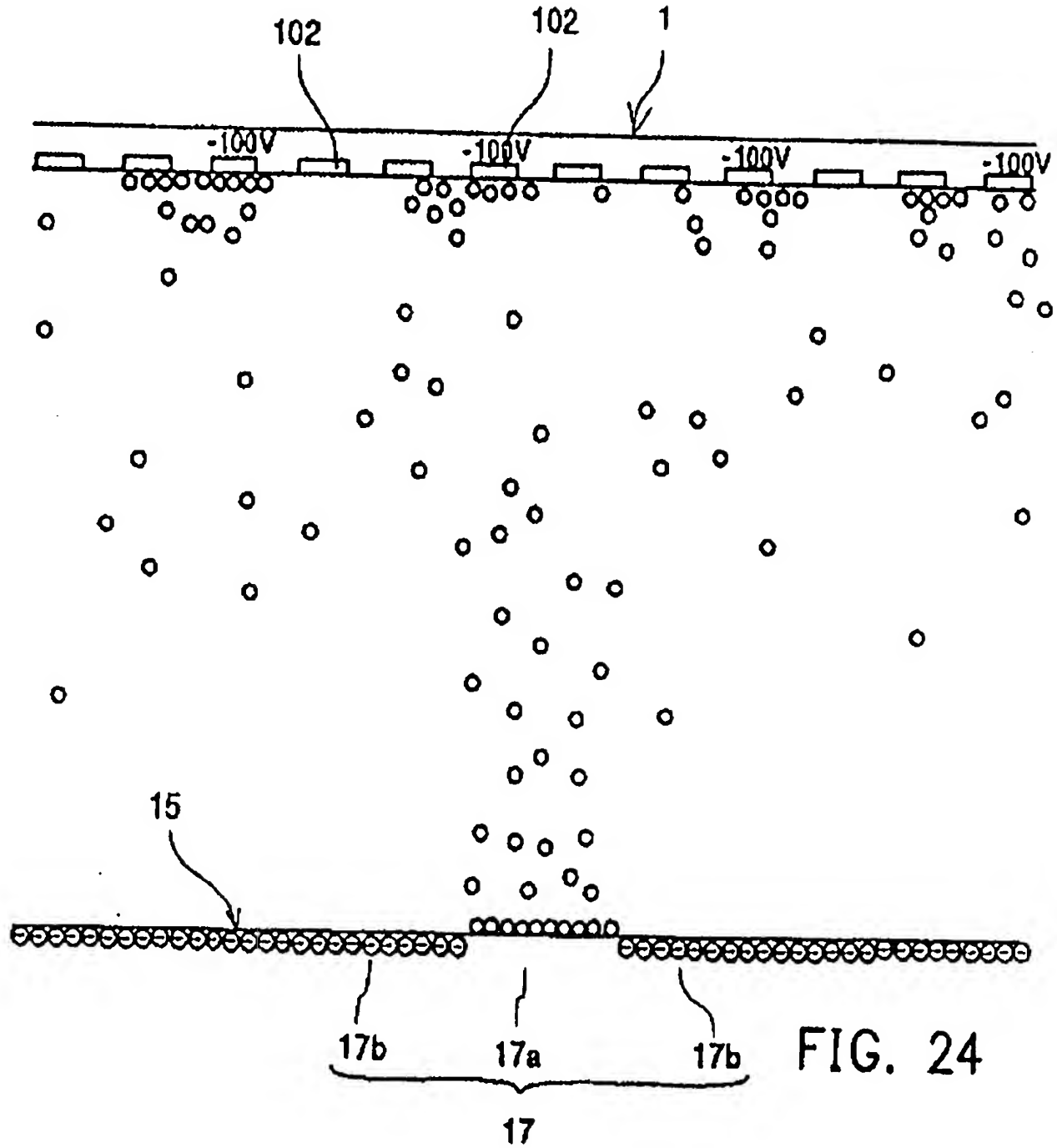


FIG. 24

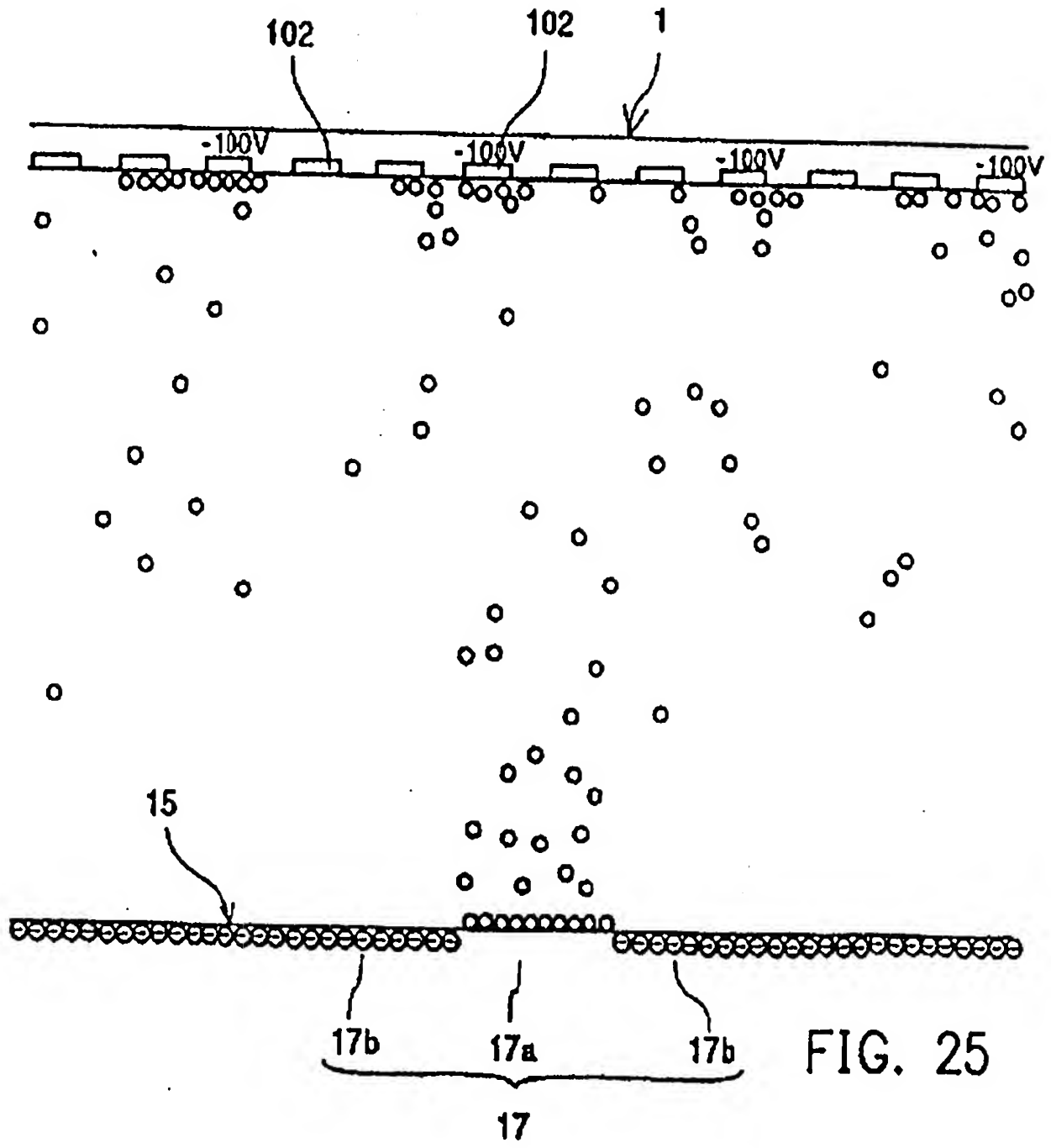


FIG. 25

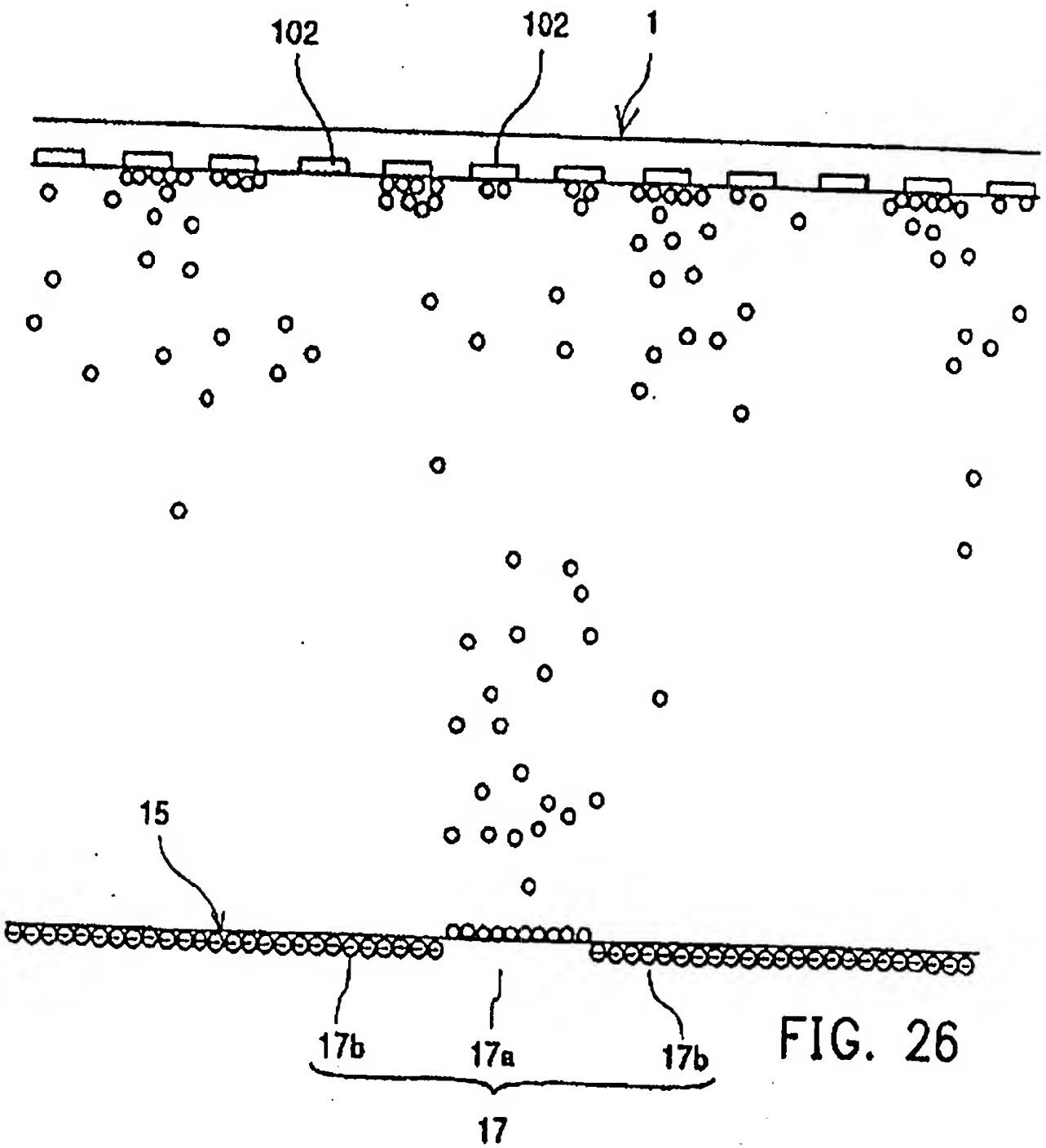


FIG. 26

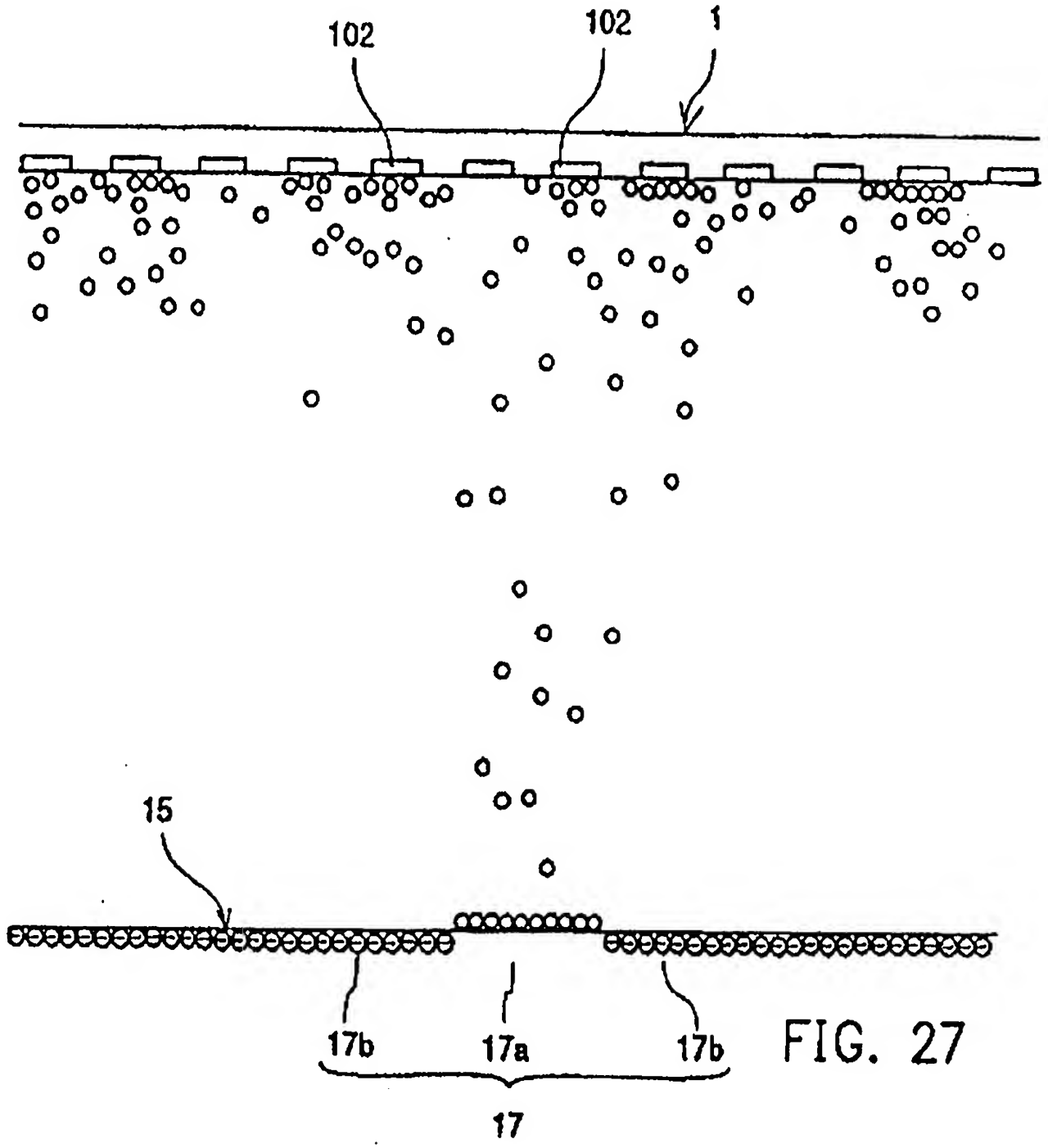


FIG. 27

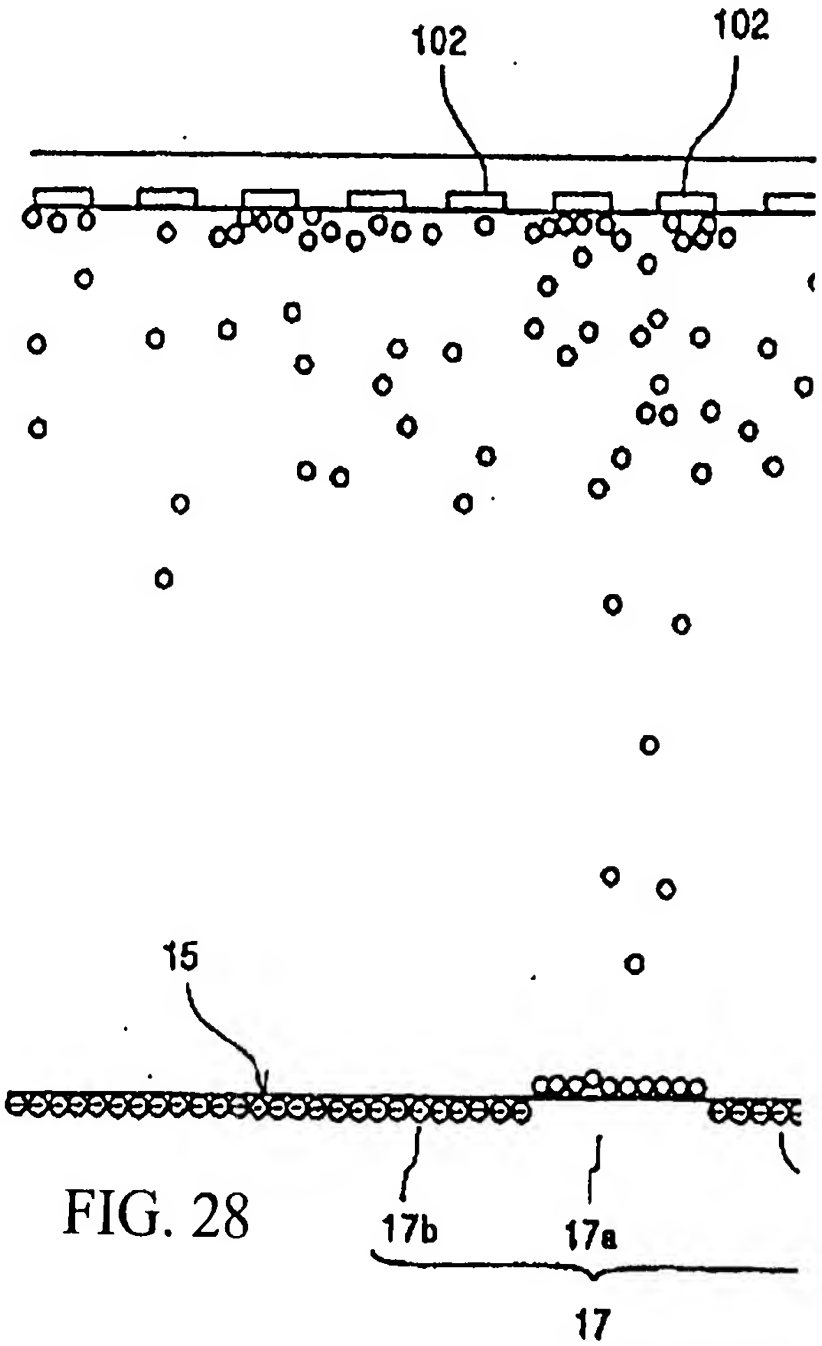


FIG. 28

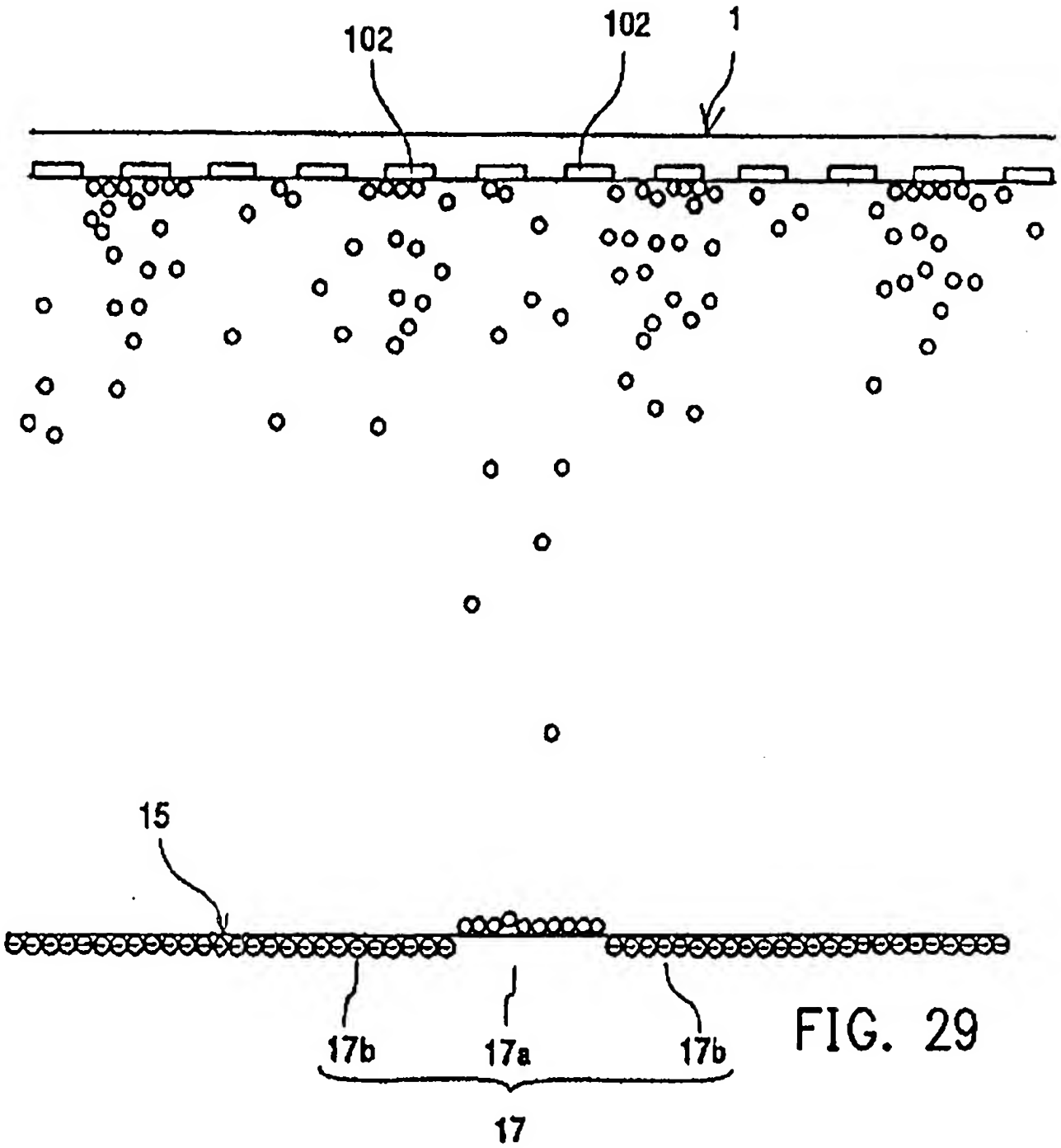
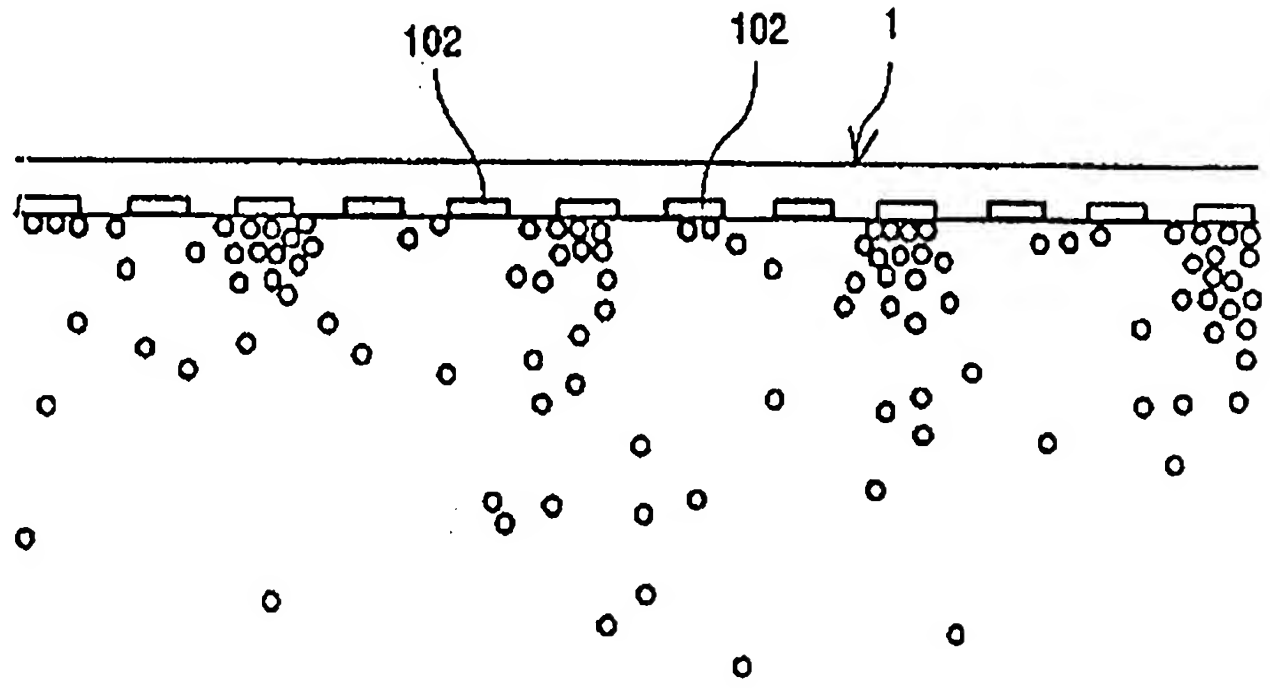


FIG. 29



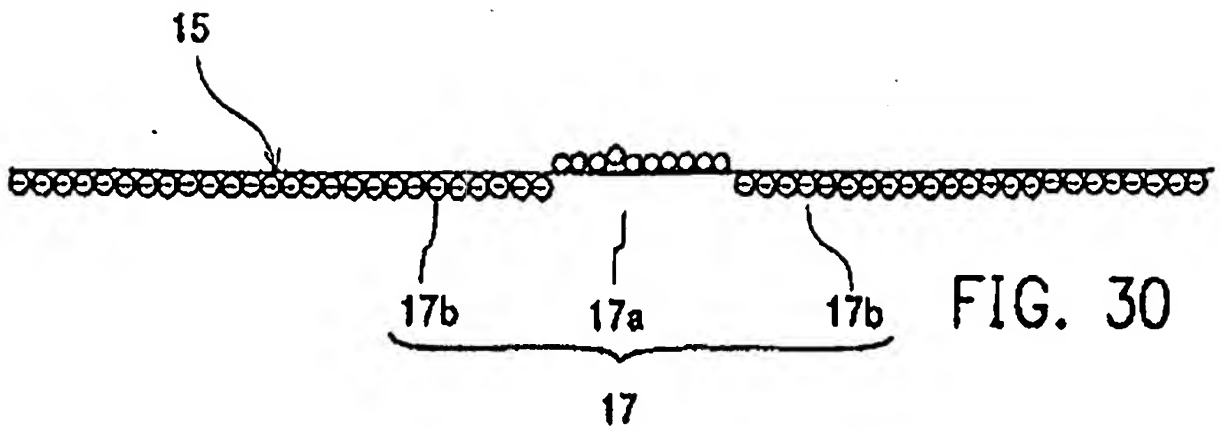


FIG. 30

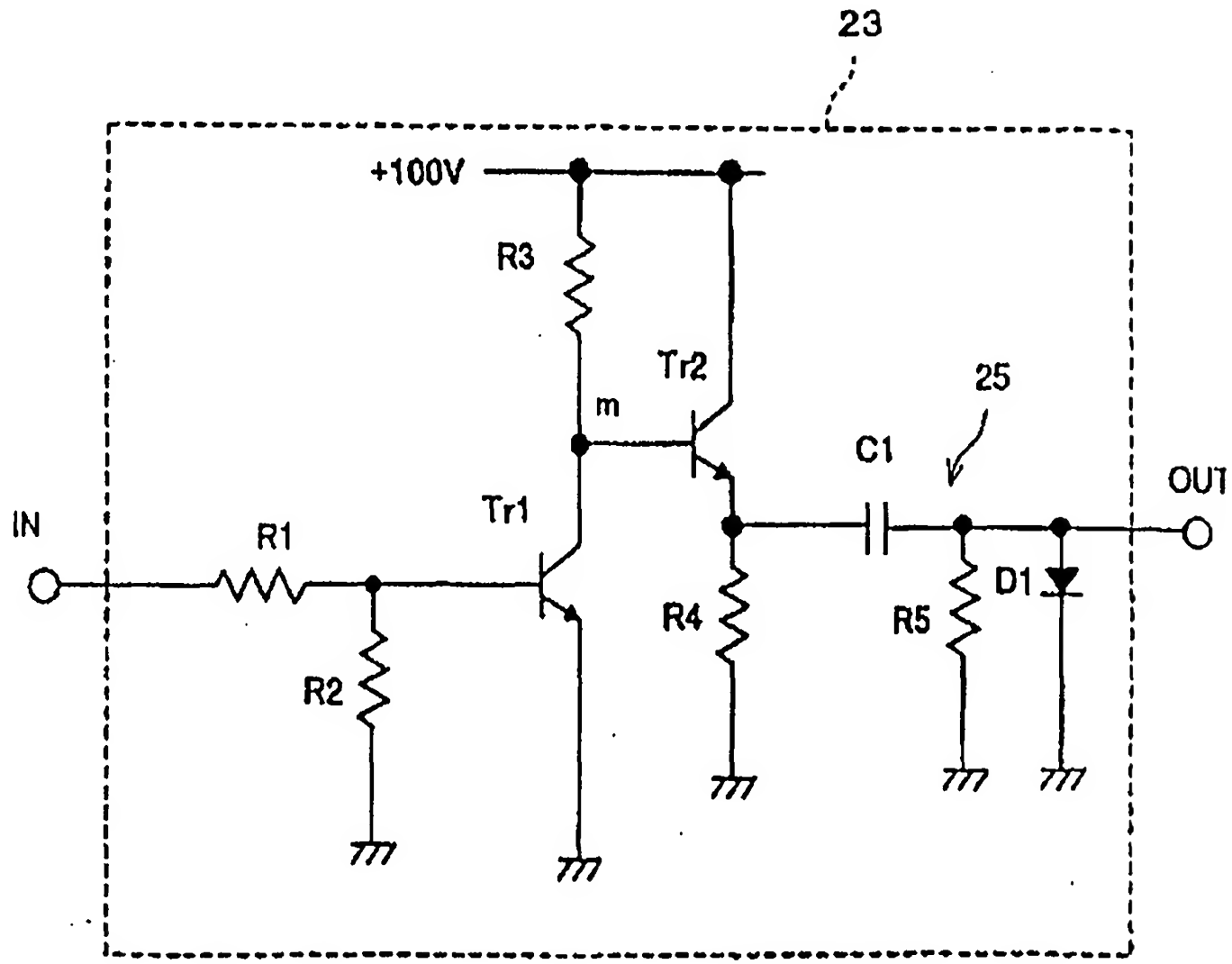


FIG. 31

FIG. 32A IN

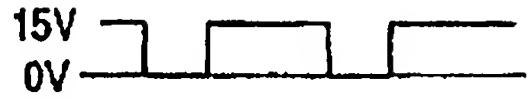


FIG. 32B m

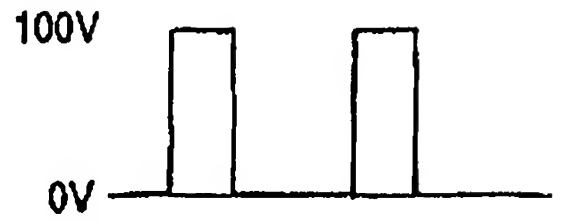
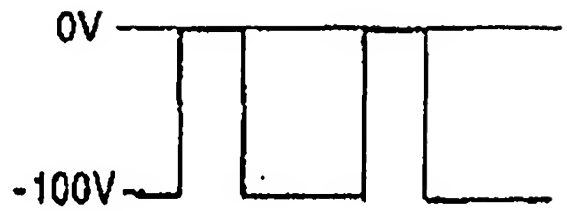


FIG. 32C OUT



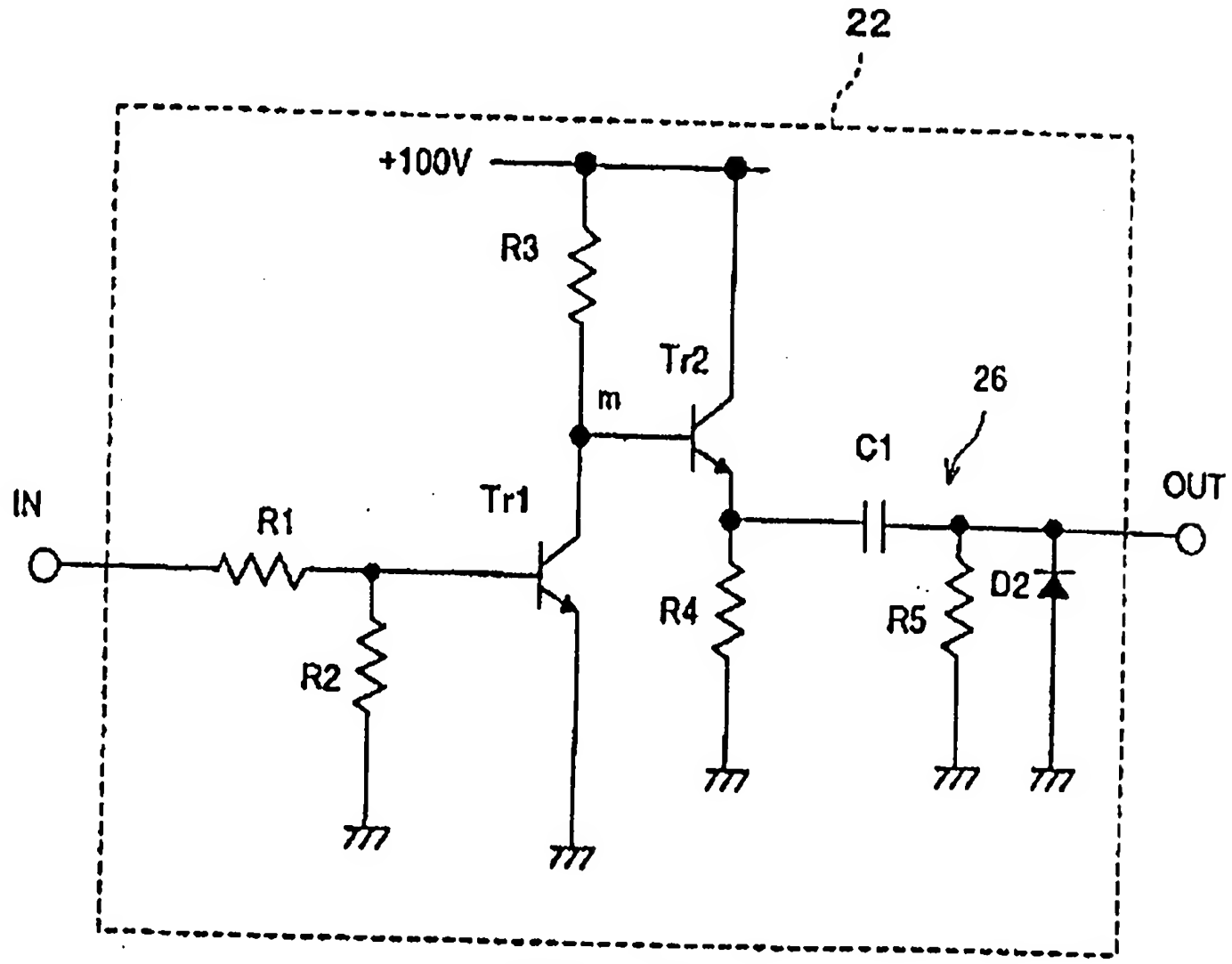


FIG. 33

FIG. 34A IN

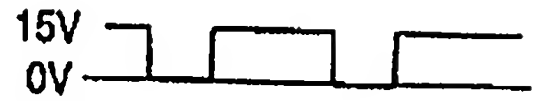


FIG. 34B m

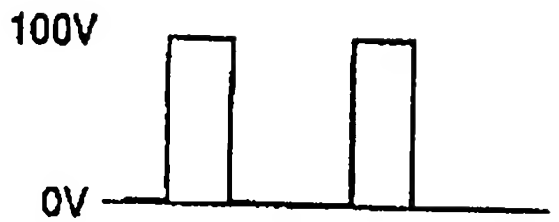
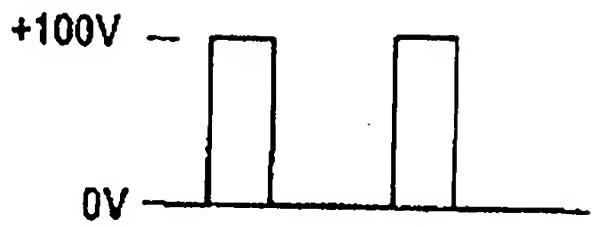


FIG. 34C OUT



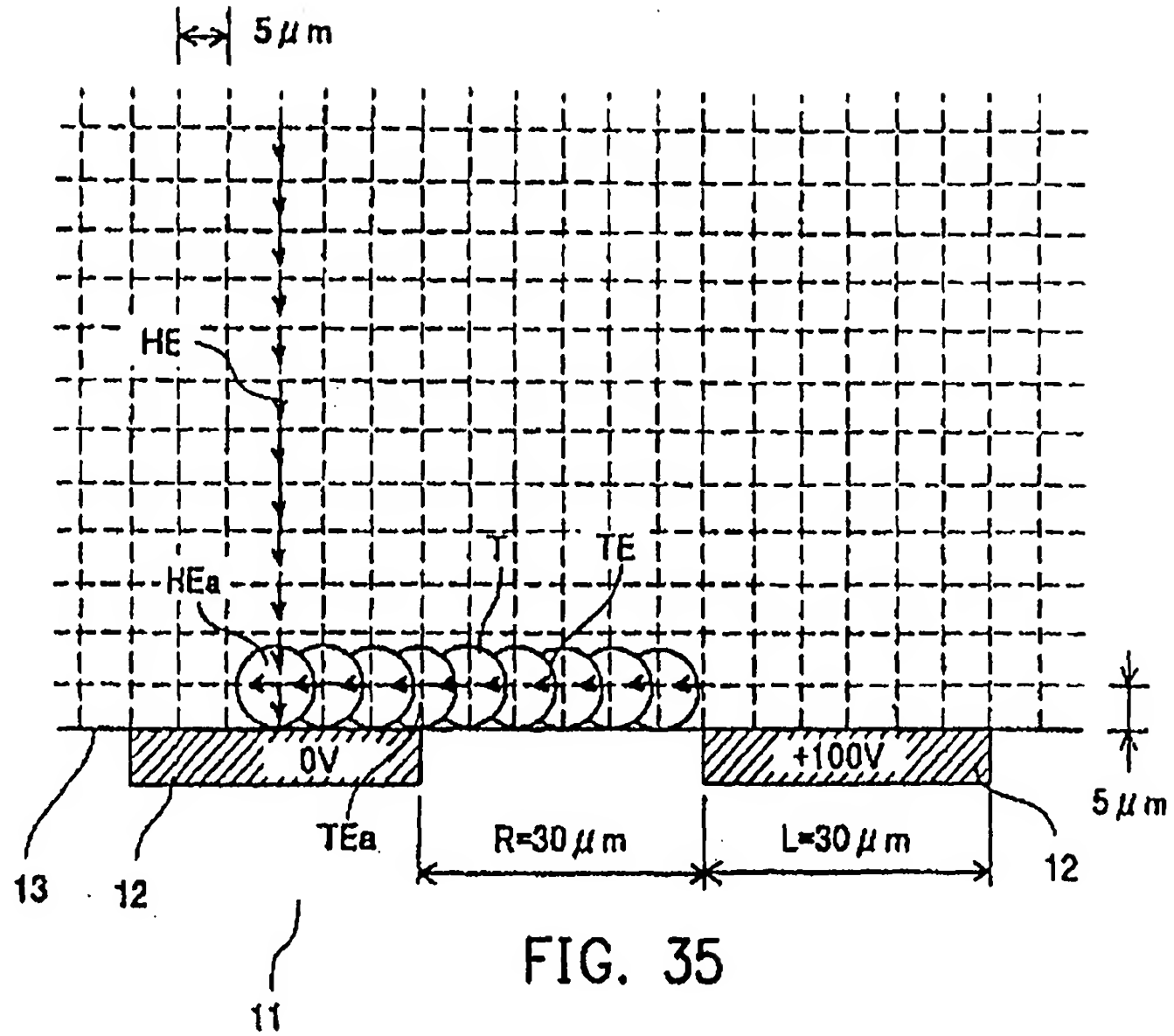


FIG. 35

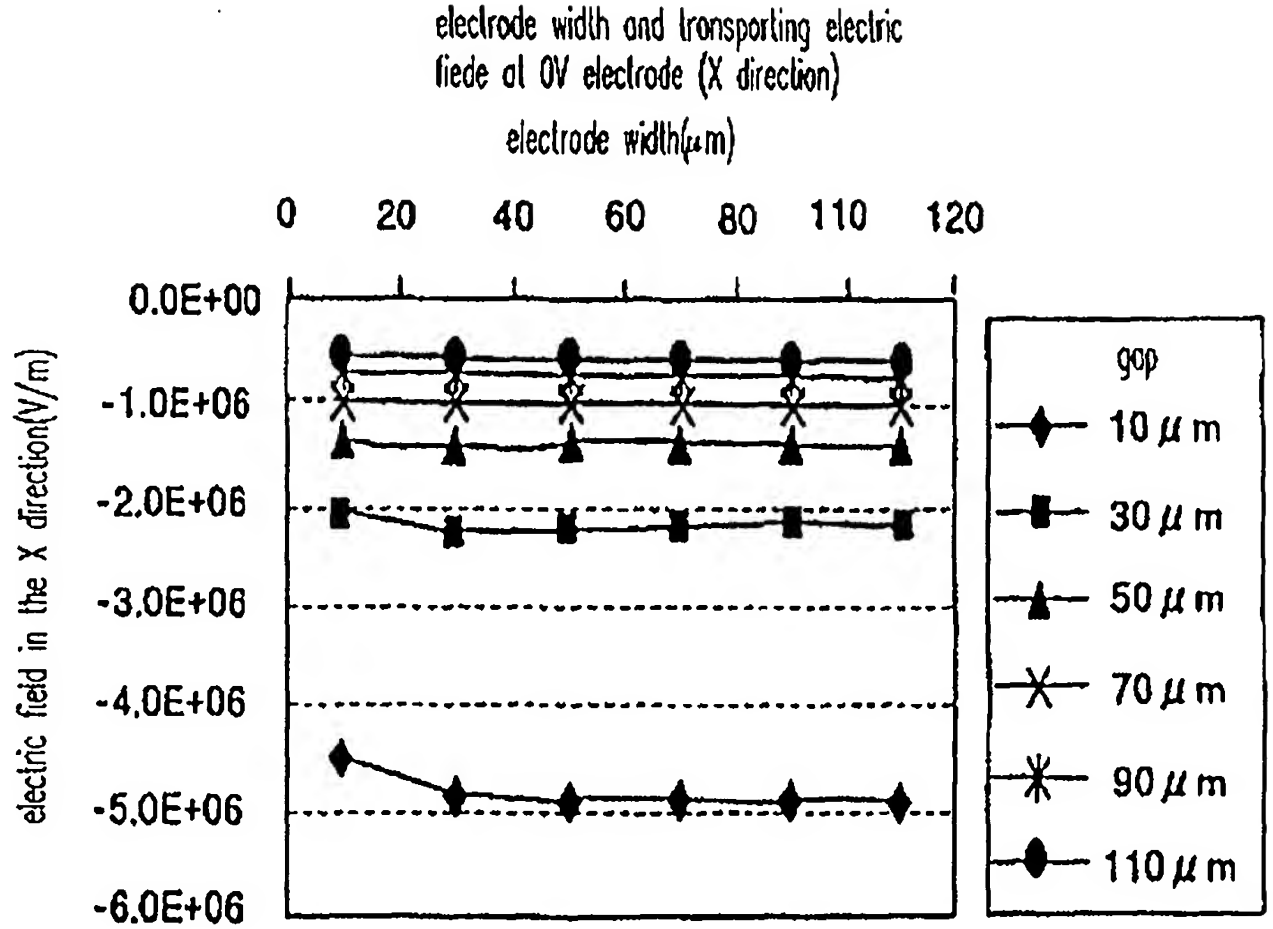

electrode width and transporting electric
field at 0V electrode (X direction)
electrode width(μm)
0
20
40
60
80
110
120
0.0E+00
-1.0E+06
-2.0E+06
-3.0E+06
-4.0E+06
-5.0E+06
-6.0E+06
electric field in the X direction(V/m)
gap
10 μm
30 μm
50 μm
70 μm
90 μm
110 μm

FIG. 36

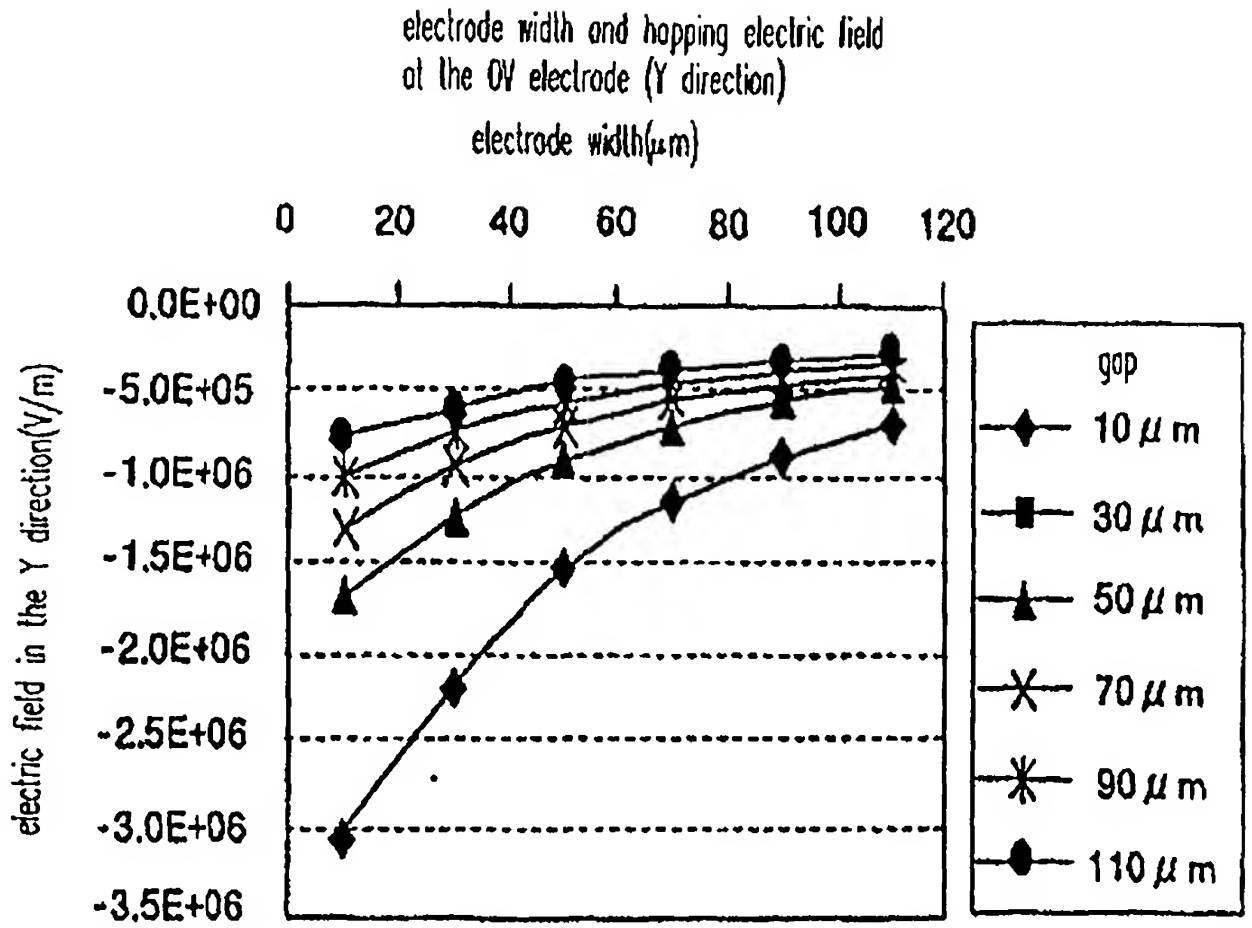

electrode width and hopping electric field
at the 0V electrode (Y direction)
electrode width(μm)
0
20
40
60
80
100
120
0.0E+00
-5.0E+05
-1.0E+06
-1.5E+06
-2.0E+06
-2.5E+06
-3.0E+06
-3.5E+06
electric field in the Y direction(V/m)
gap
10 μm
30 μm
50 μm
70 μm
90 μm
110 μm

FIG. 37

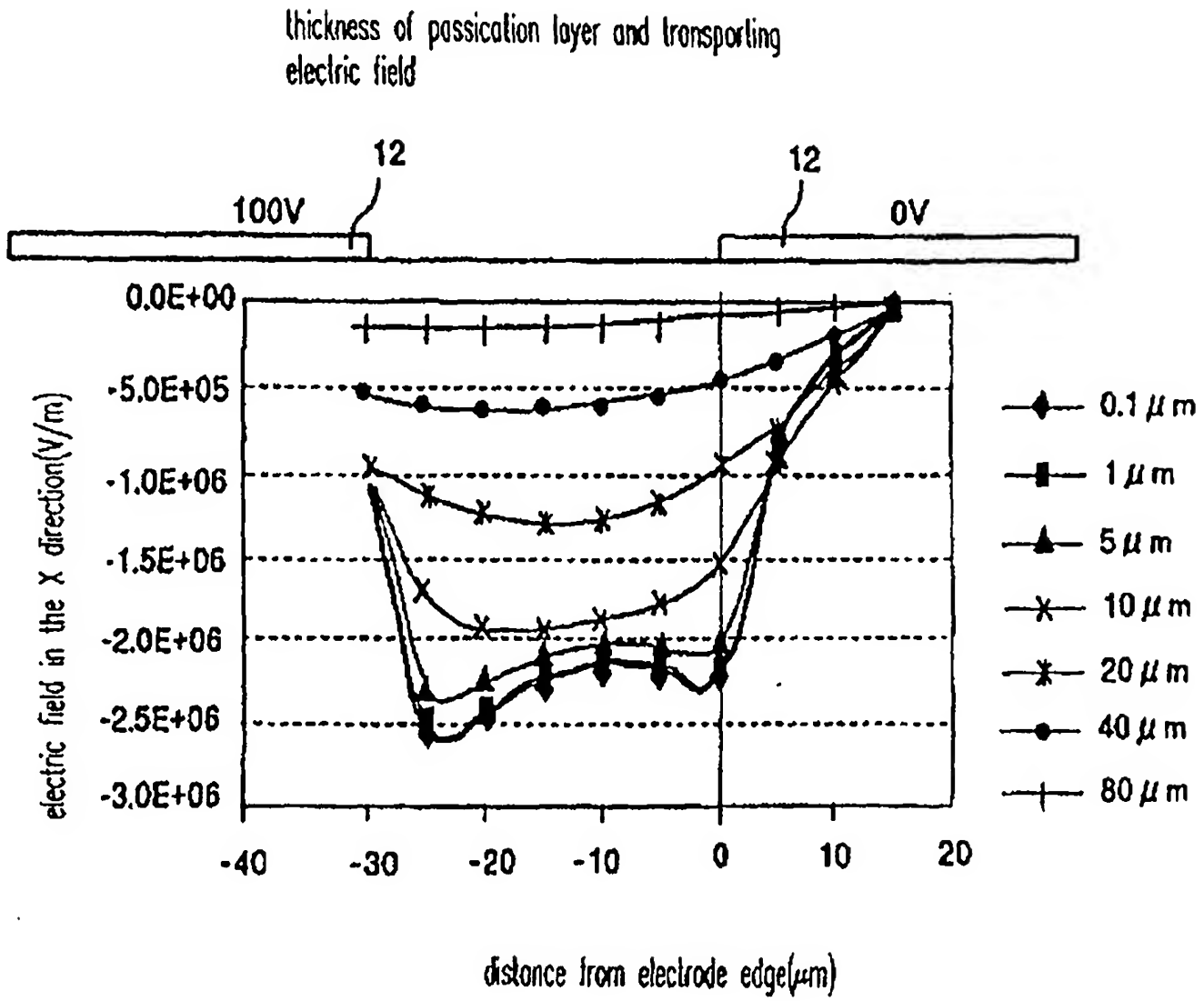

thickness of passication layer and transporting electric field
12
12
100V
0V
0.0E+00
-5.0E+05
-1.0E+06
-1.5E+06
-2.0E+06
-2.5E+06
-3.0E+06
electric field in the X direction(V/m)
-40
-30
-20
-10
0
10
20
distance from electrode edge(μm)
0.1 μm
1 μm
5 μm
10 μm
20 μm
40 μm
80 μm

FIG. 38

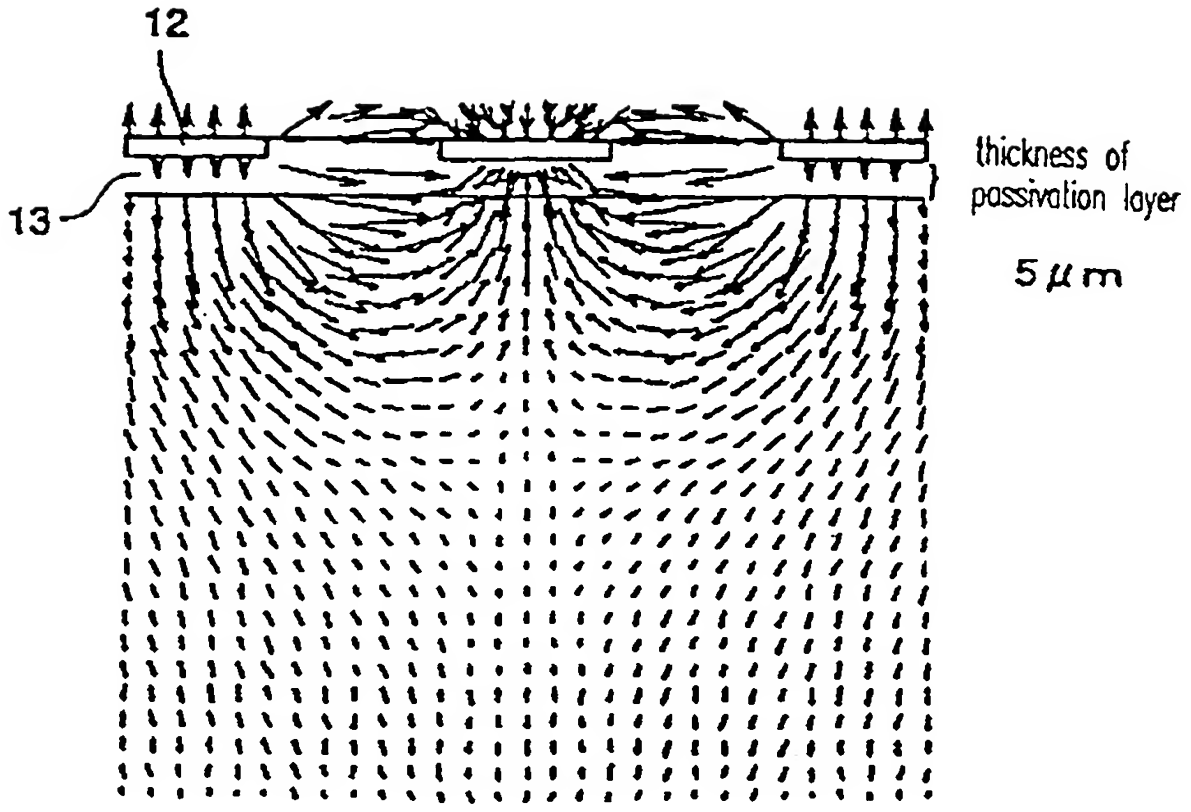

12
13
thickness of
passivation layer
5 μm

FIG. 39

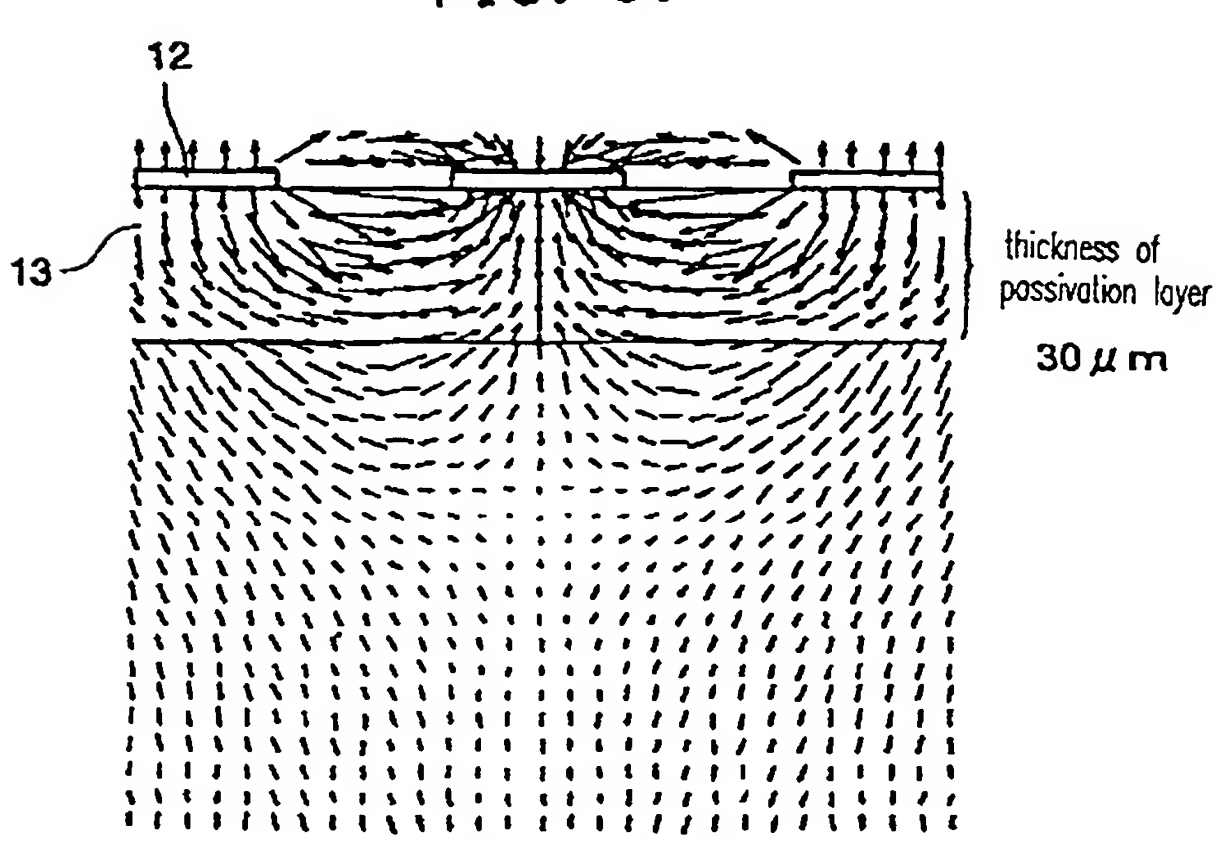

12
13
thickness of
passivation layer
30 μm

FIG. 40

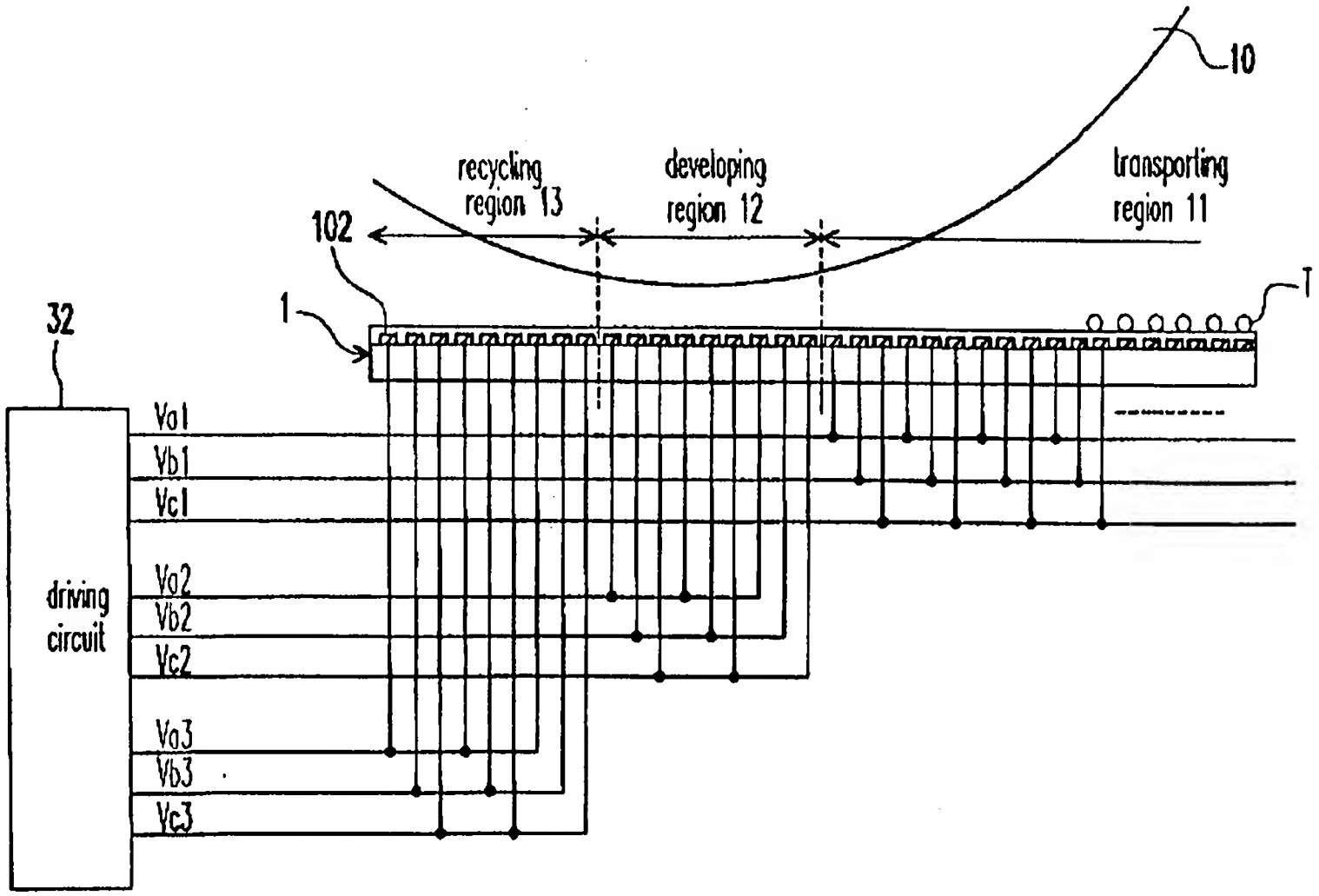

10
recycling region 13
developing region 12
transporting region 11
102
1
T
32
Va1
Vb1
Vc1
Va2
Vb2
Vc2
Va3
Vb3
Vc3
driving circuit

FIG. 41

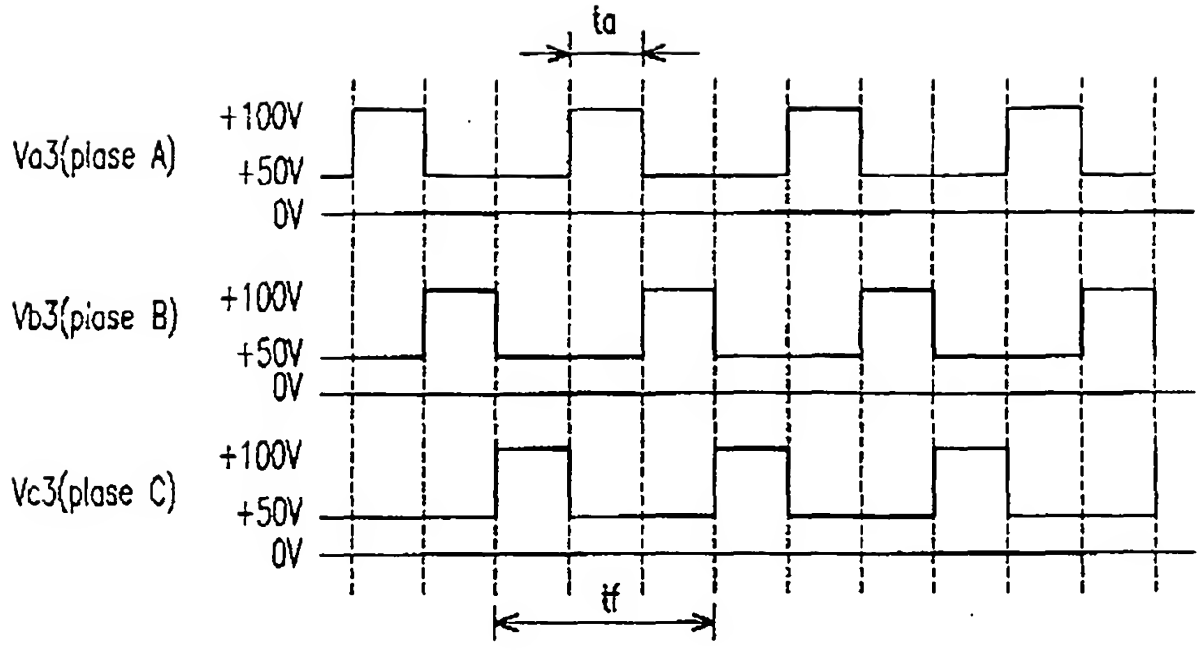
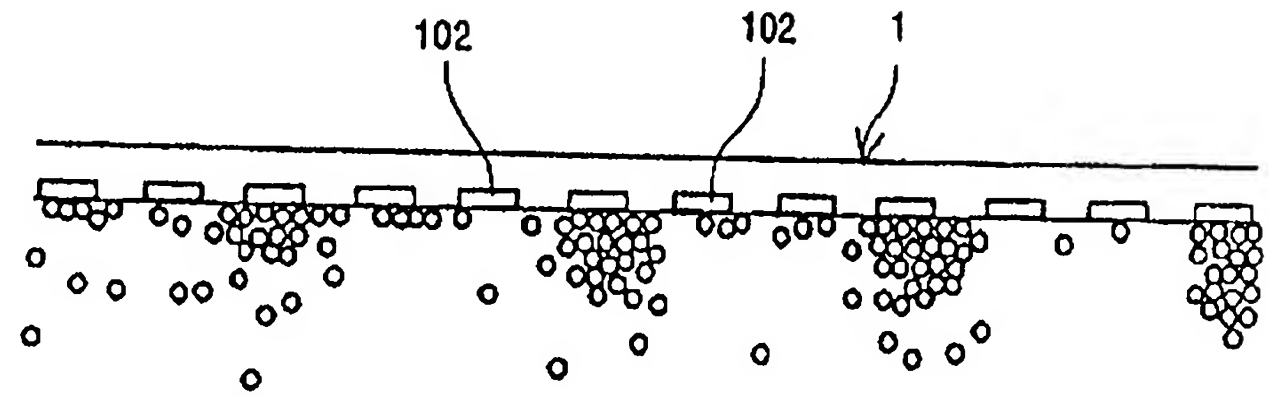

ta
Va3(plase A)
+100V
+50V
0V
Vb3(plase B)
+100V
+50V
0V
Vc3(plase C)
+100V
+50V
0V
tf

FIG. 42



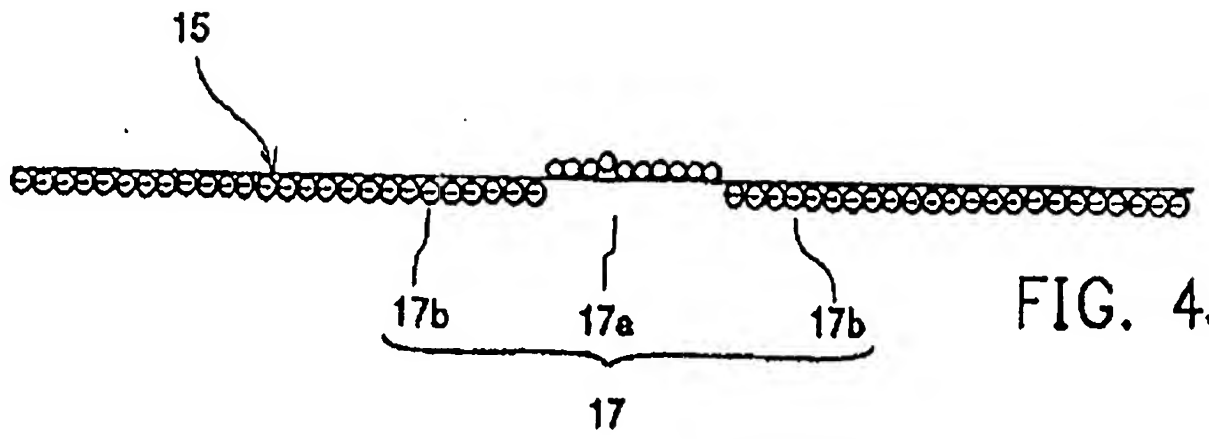


FIG. 43

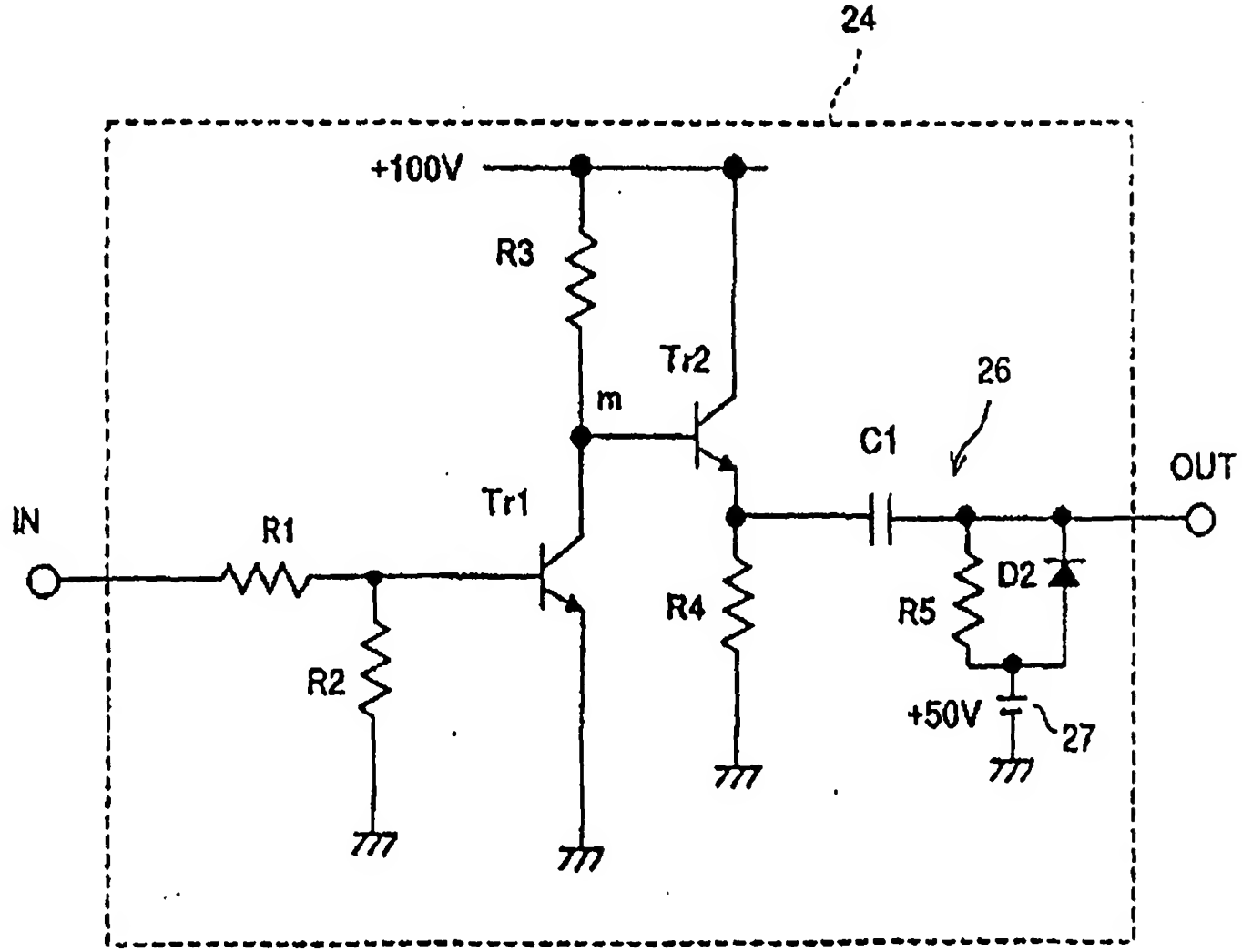
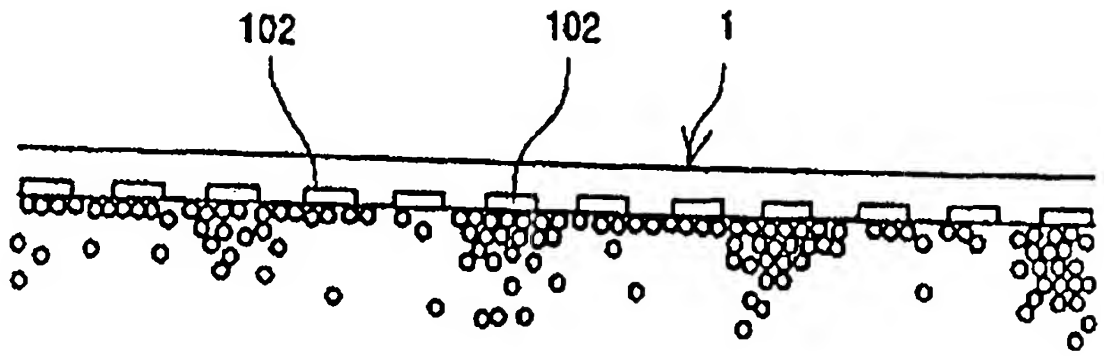


FIG. 44



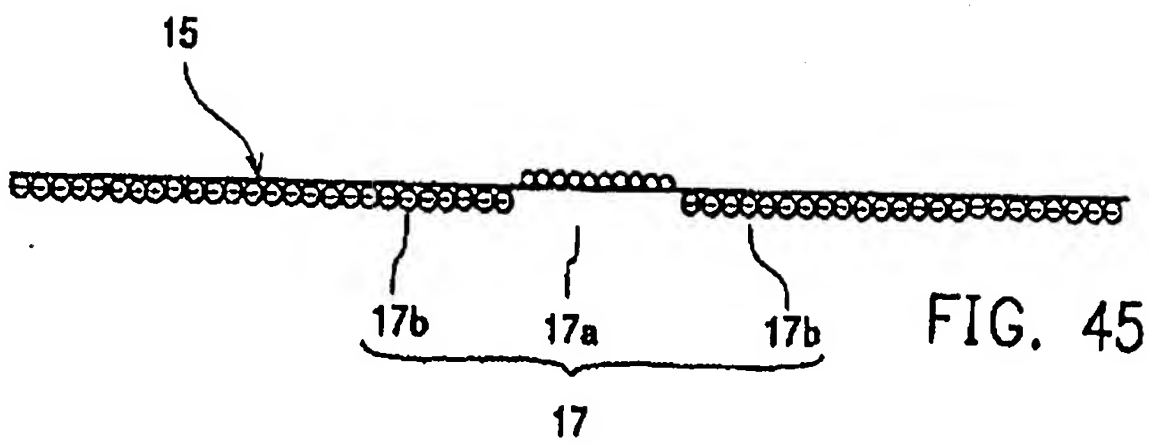
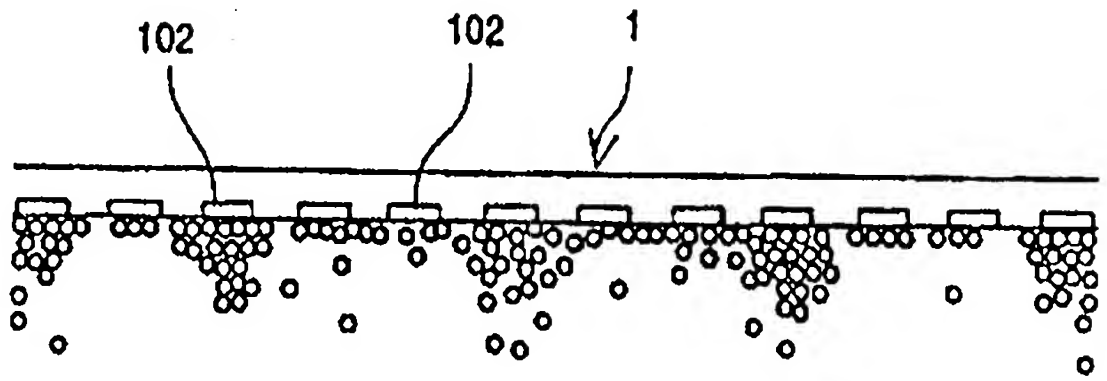


FIG. 45



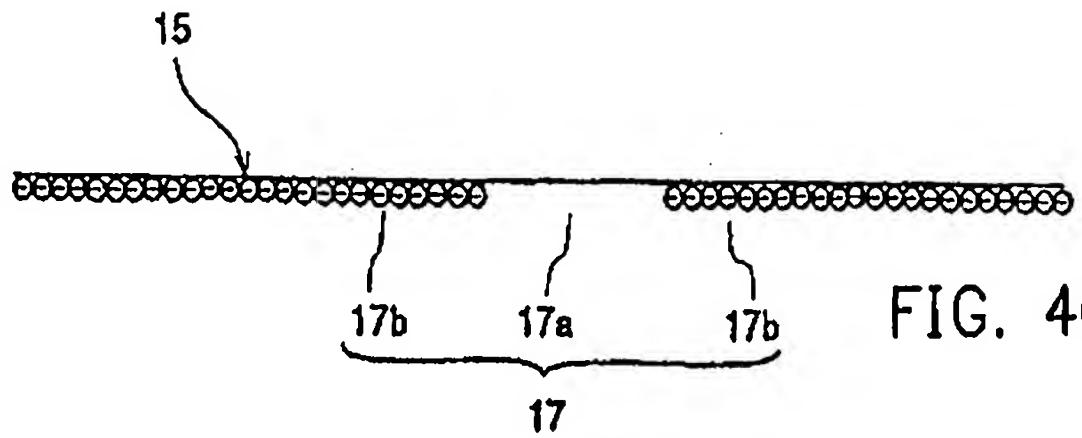


FIG. 46

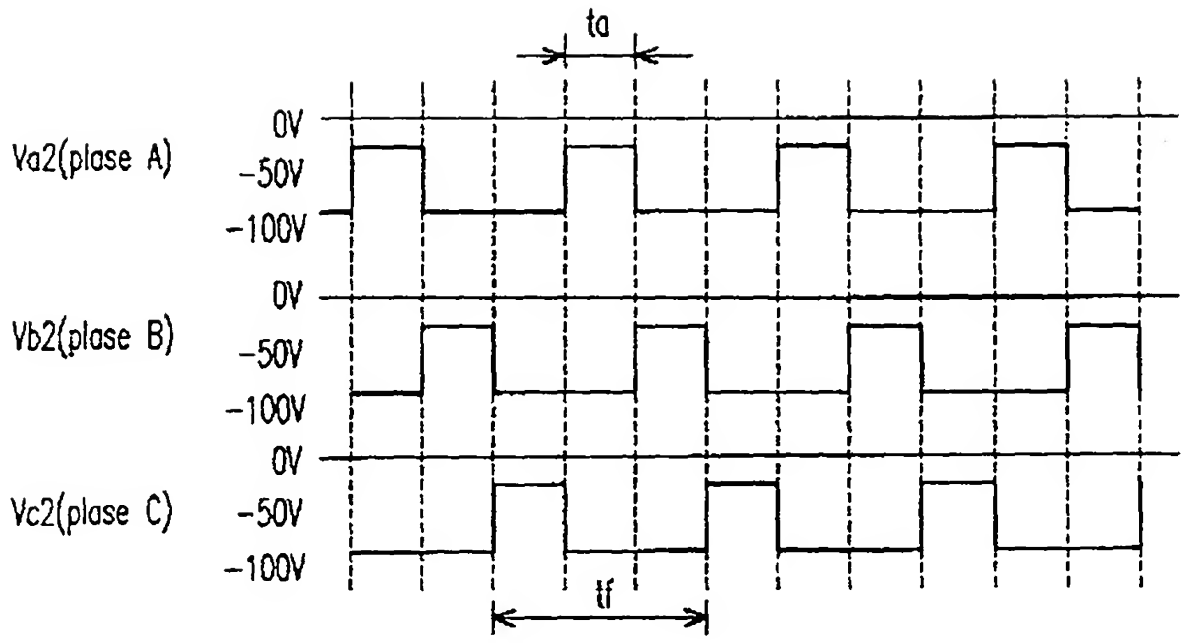

ta
Va2(plase A)
0V
-50V
-100V
Vb2(plase B)
0V
-50V
-100V
Vc2(plase C)
0V
-50V
-100V
tf

FIG. 47

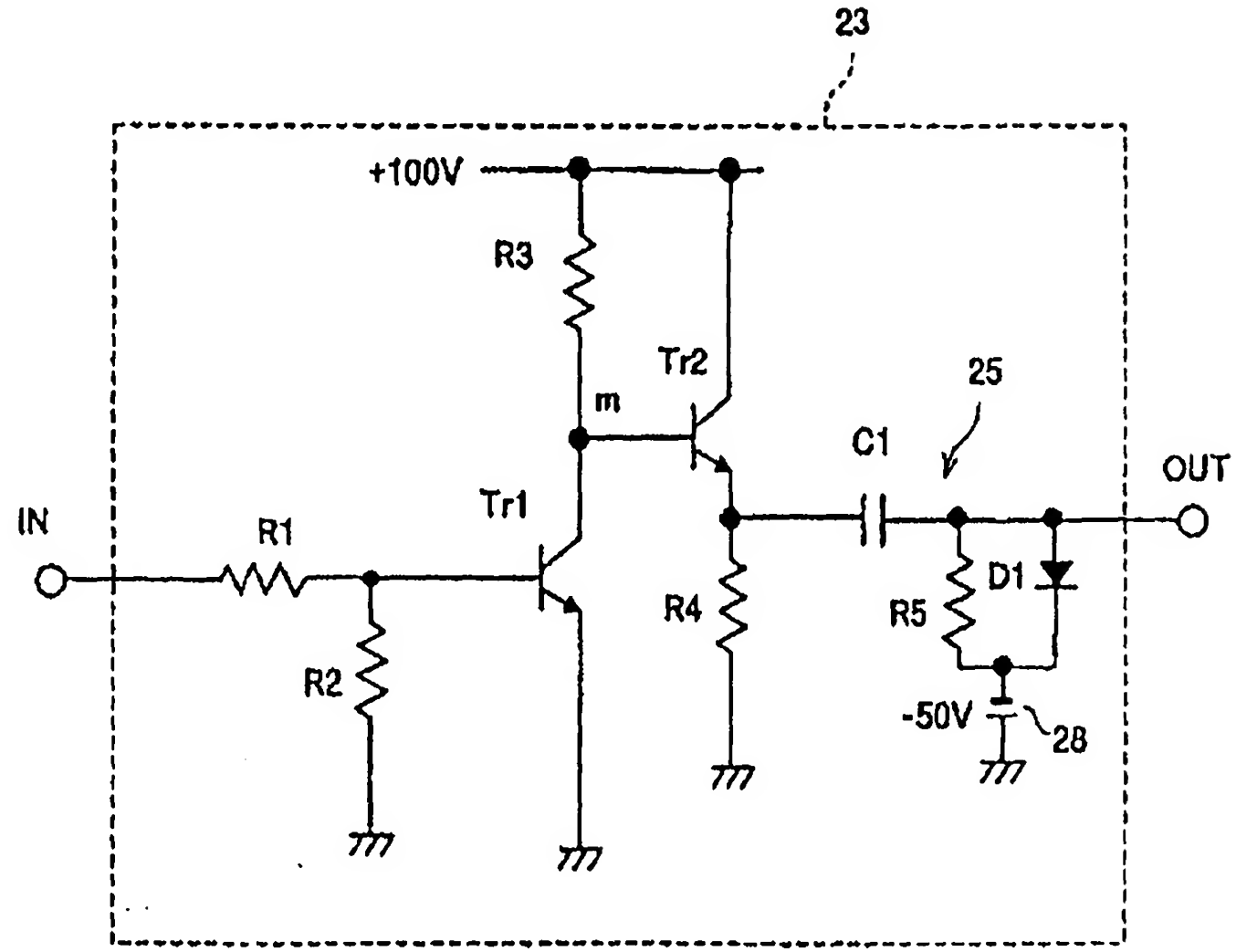


FIG. 48

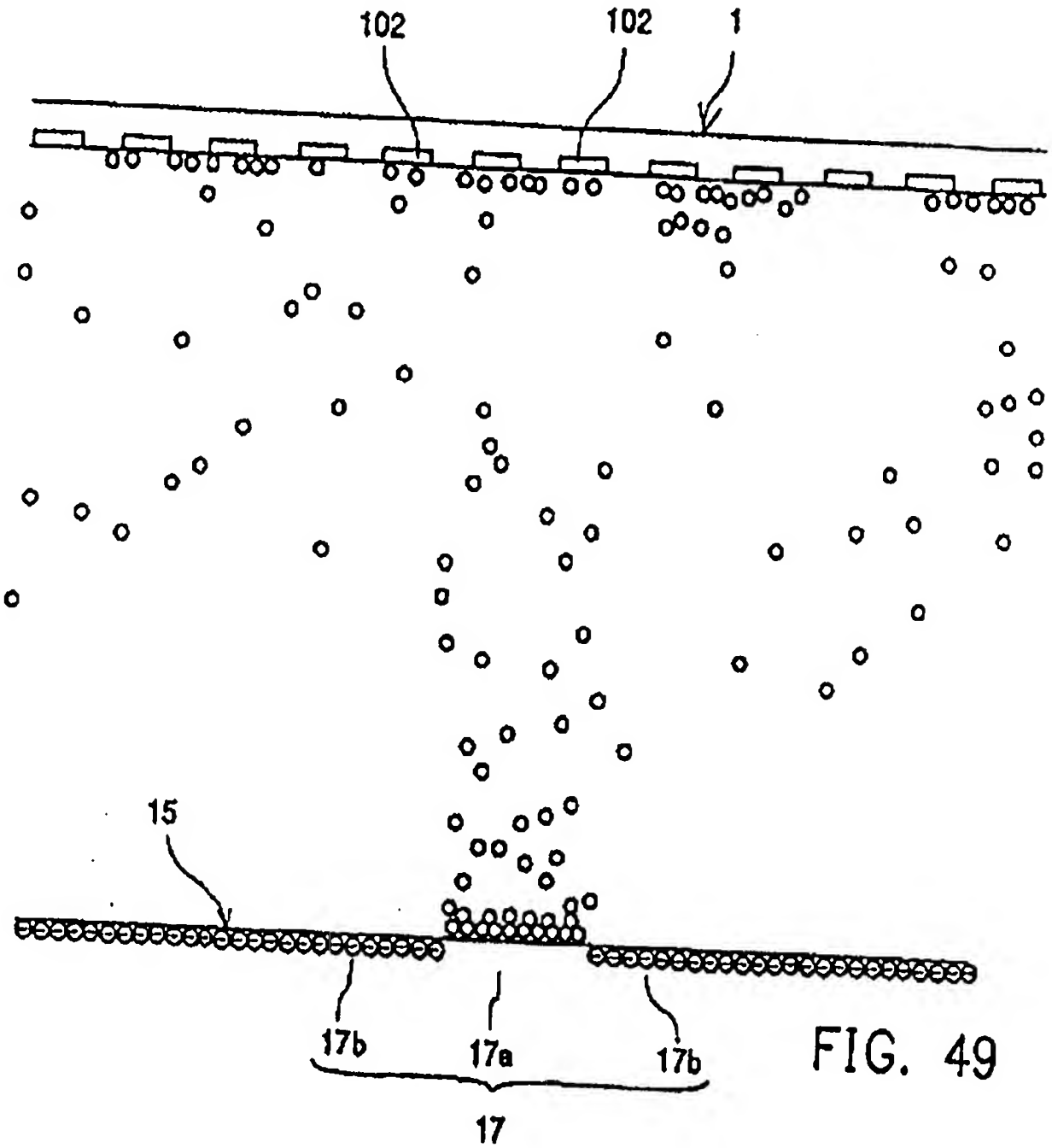
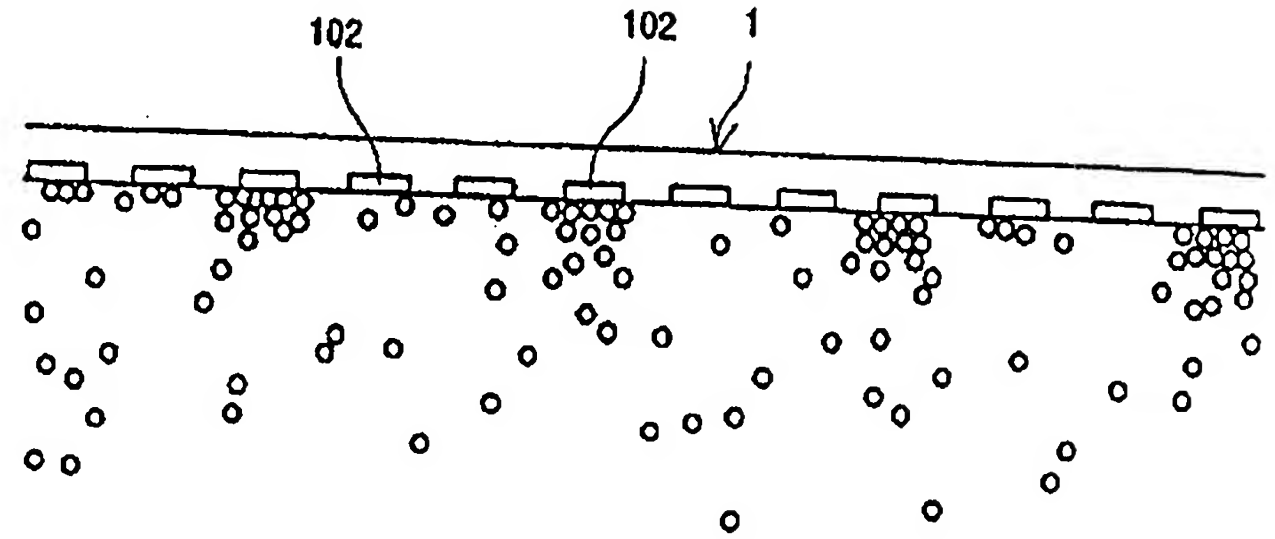


FIG. 49



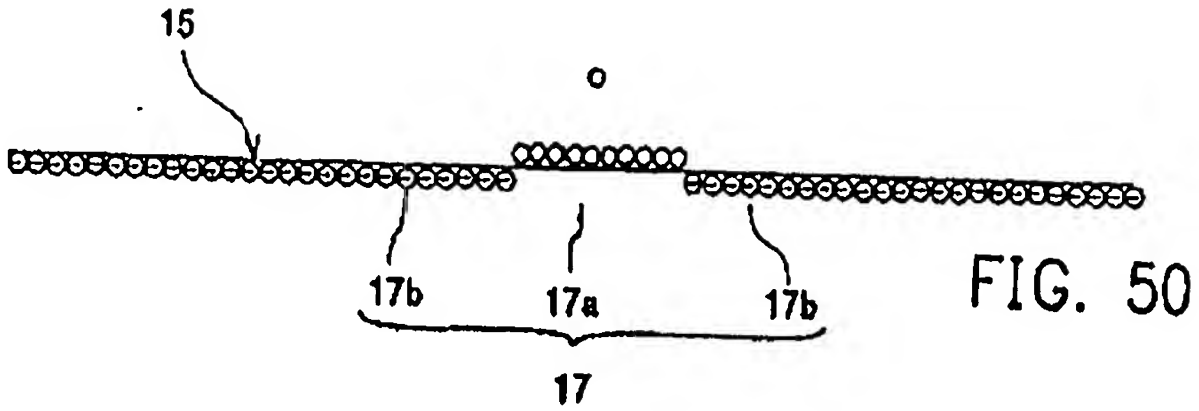


FIG. 50

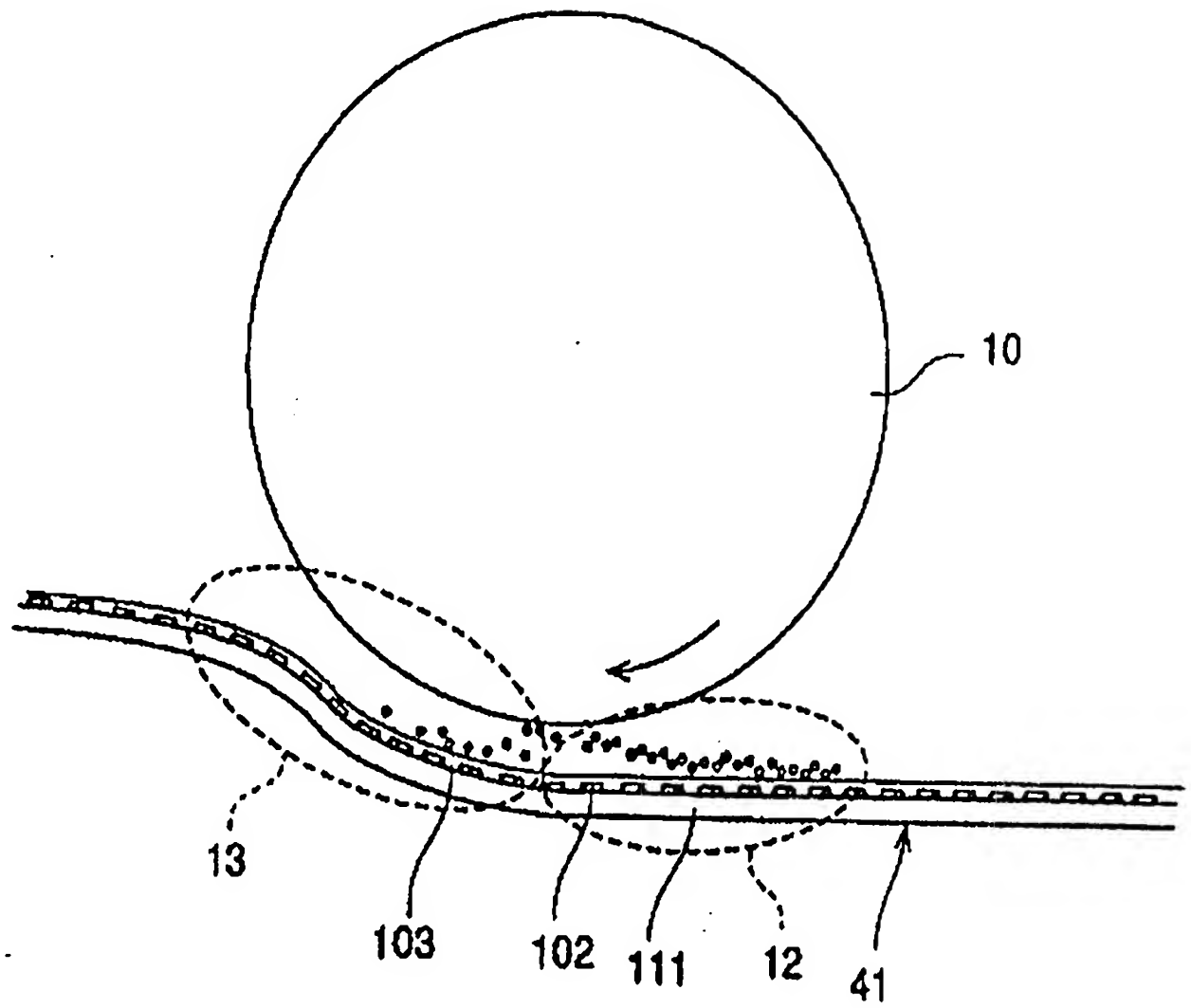


FIG. 51

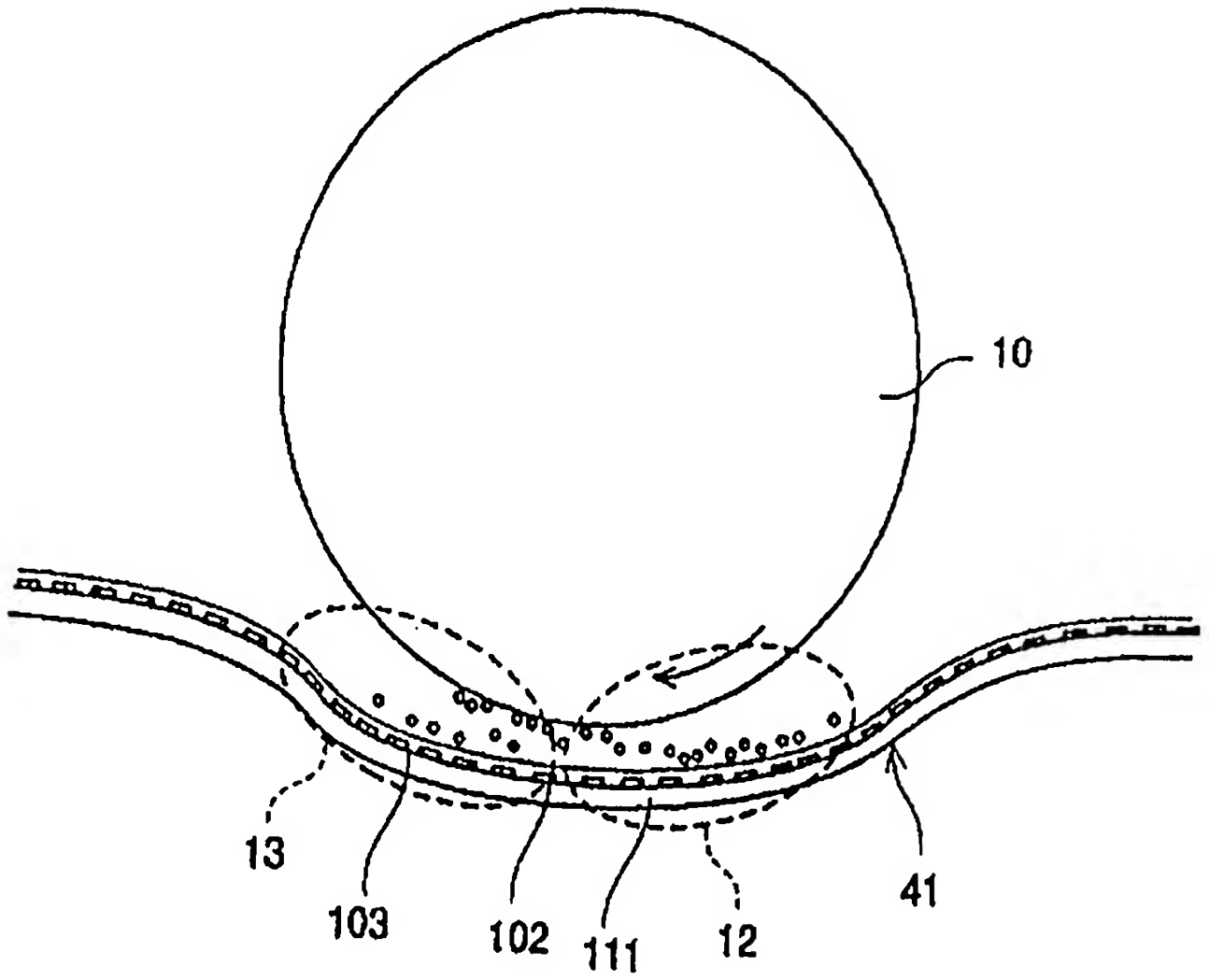


FIG. 52

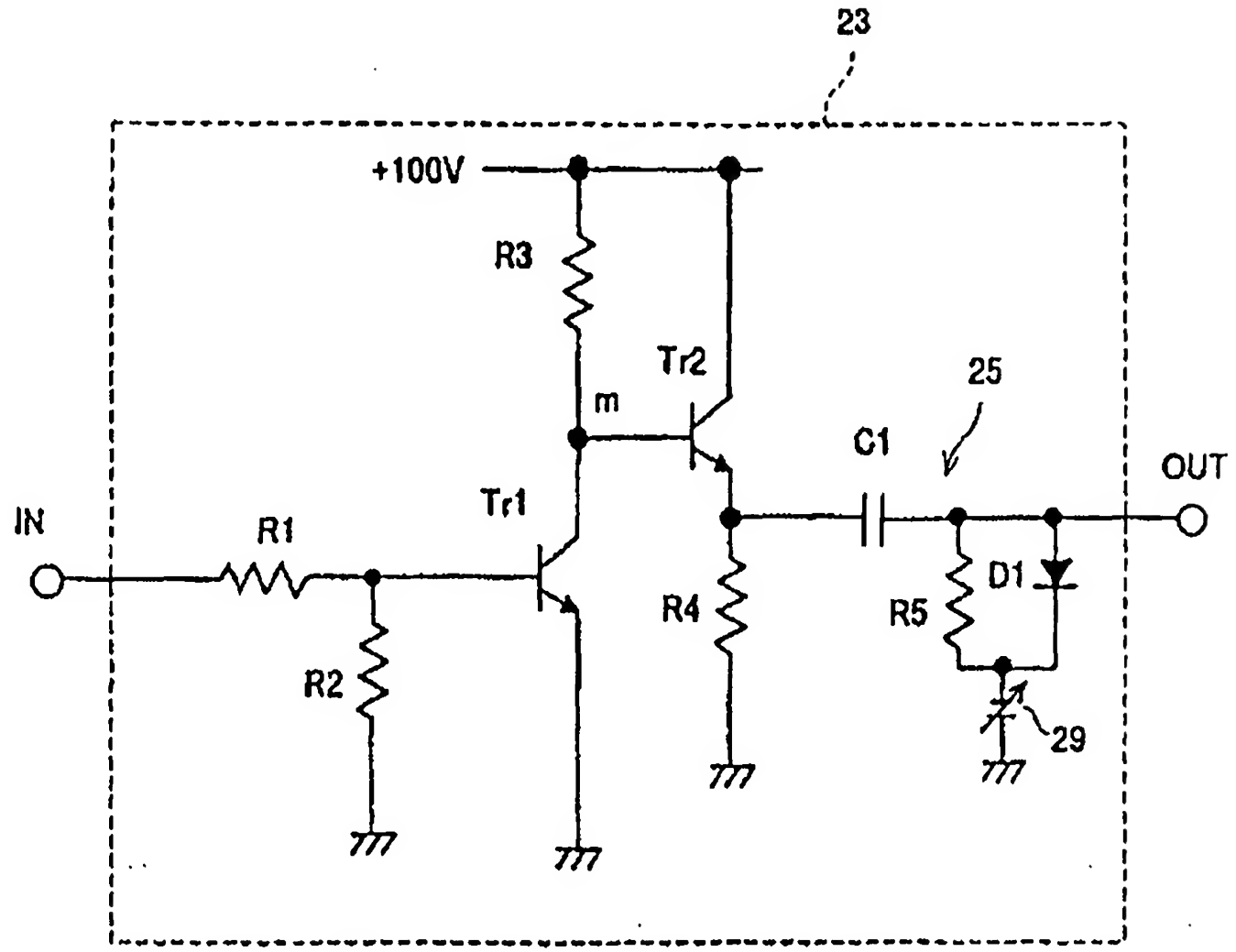


FIG. 53

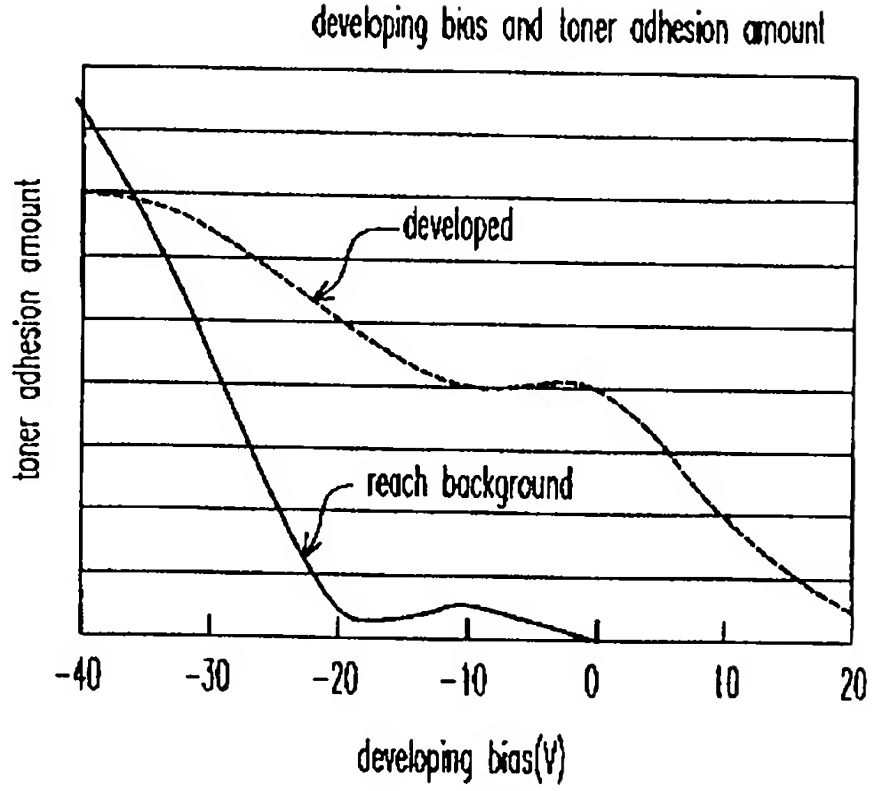

developing bias and toner adhesion amount
toner adhesion amount
developed
reach background
-40
-30
-20
-10
0
10
20
developing bias(V)

FIG. 54

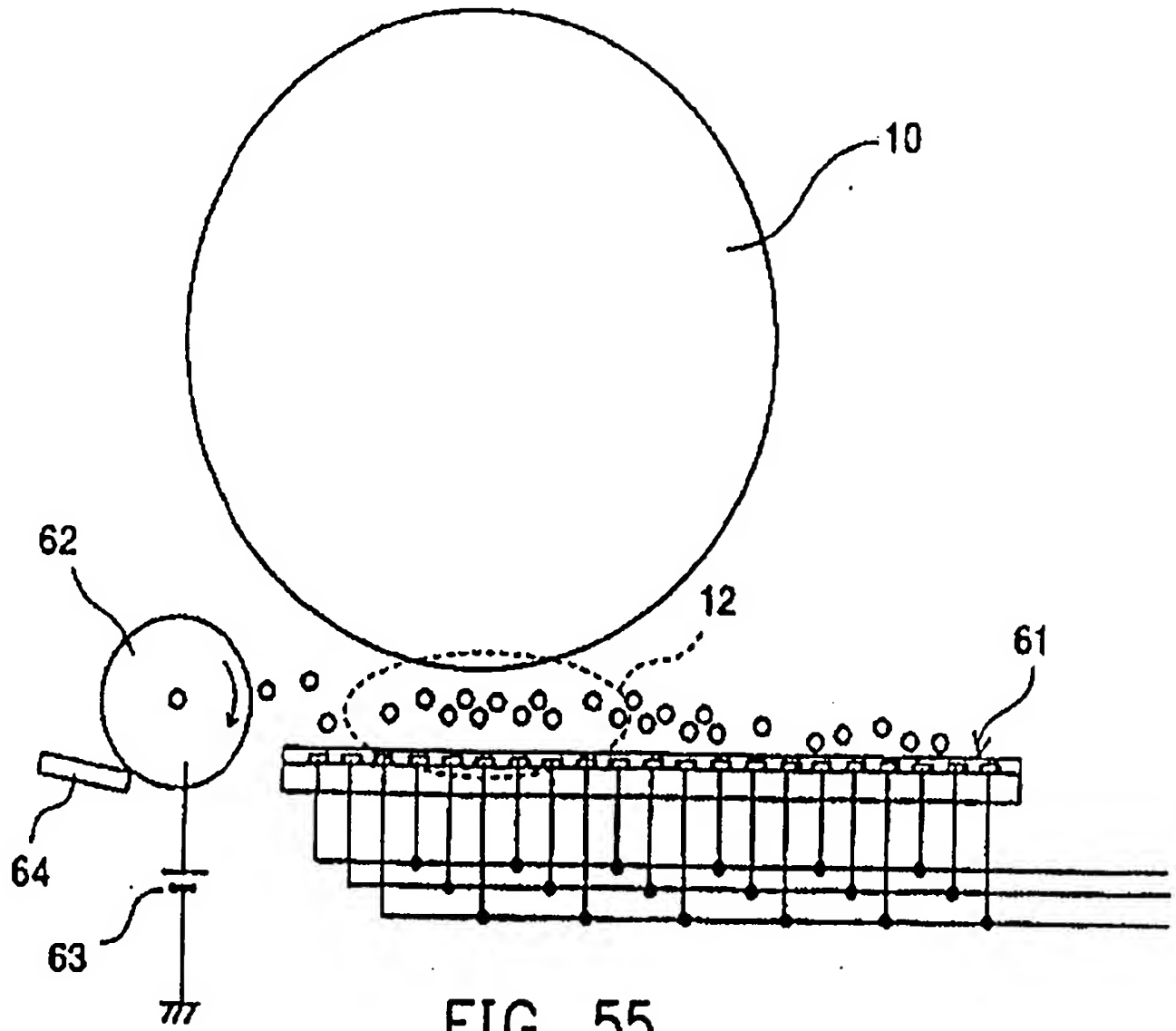


FIG. 55

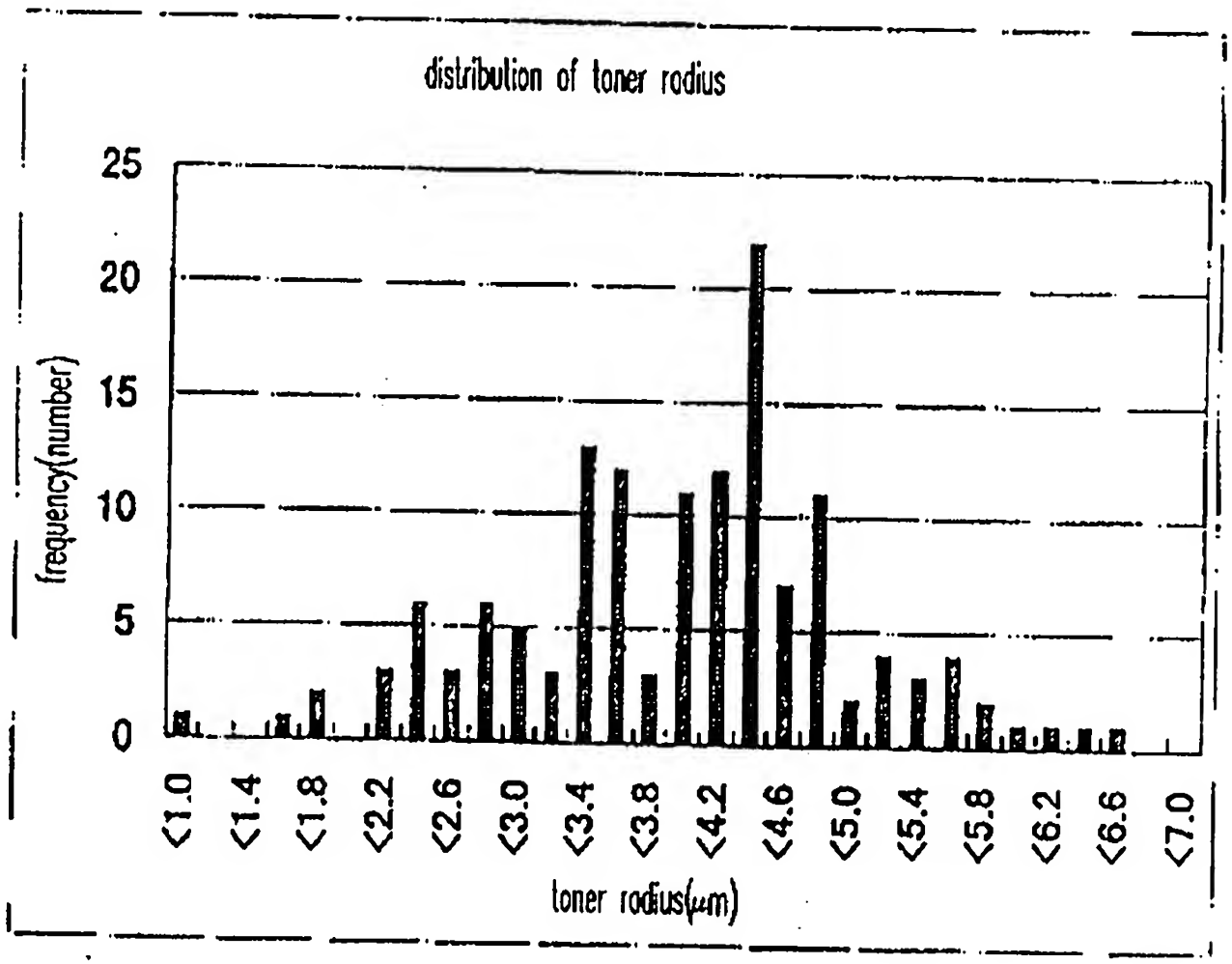

distribution of toner radius
25
20
15
10
5
0
frequency(number)
<1.0
<1.4
<1.8
<2.2
<2.6
<3.0
<3.4
<3.8
<4.2
<4.6
<5.0
<5.4
<5.8
<6.2
<6.6
<7.0
toner radius(μm)

FIG. 56

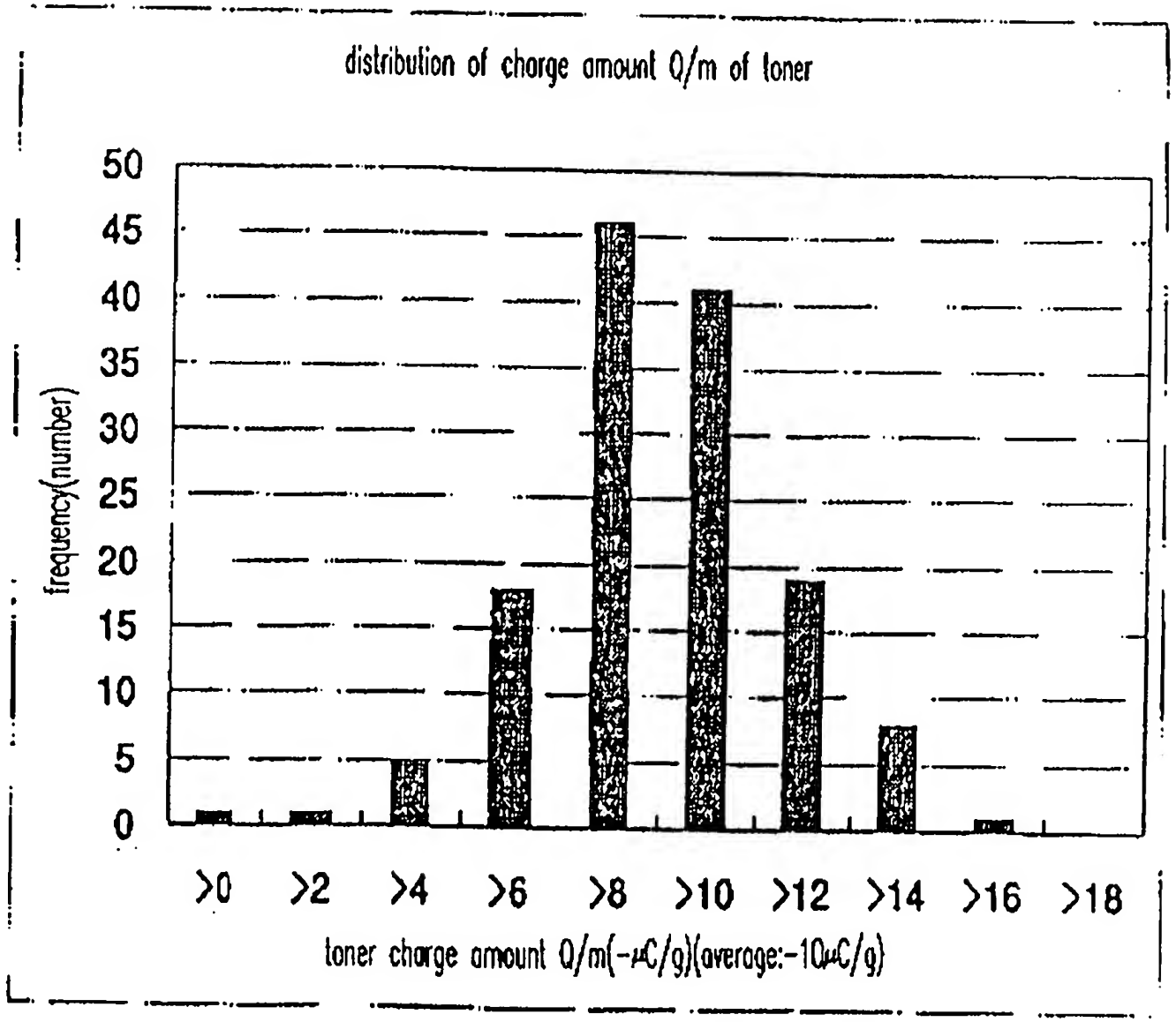

distribution of charge amount Q/m of toner
frequency(number)
50
45
40
35
30
25
20
15
10
5
0
>0
>2
>4
>6
>8
>10
>12
>14
>16
>18
toner charge amount Q/m(-μC/g)(average:-10μC/g)

FIG. 57

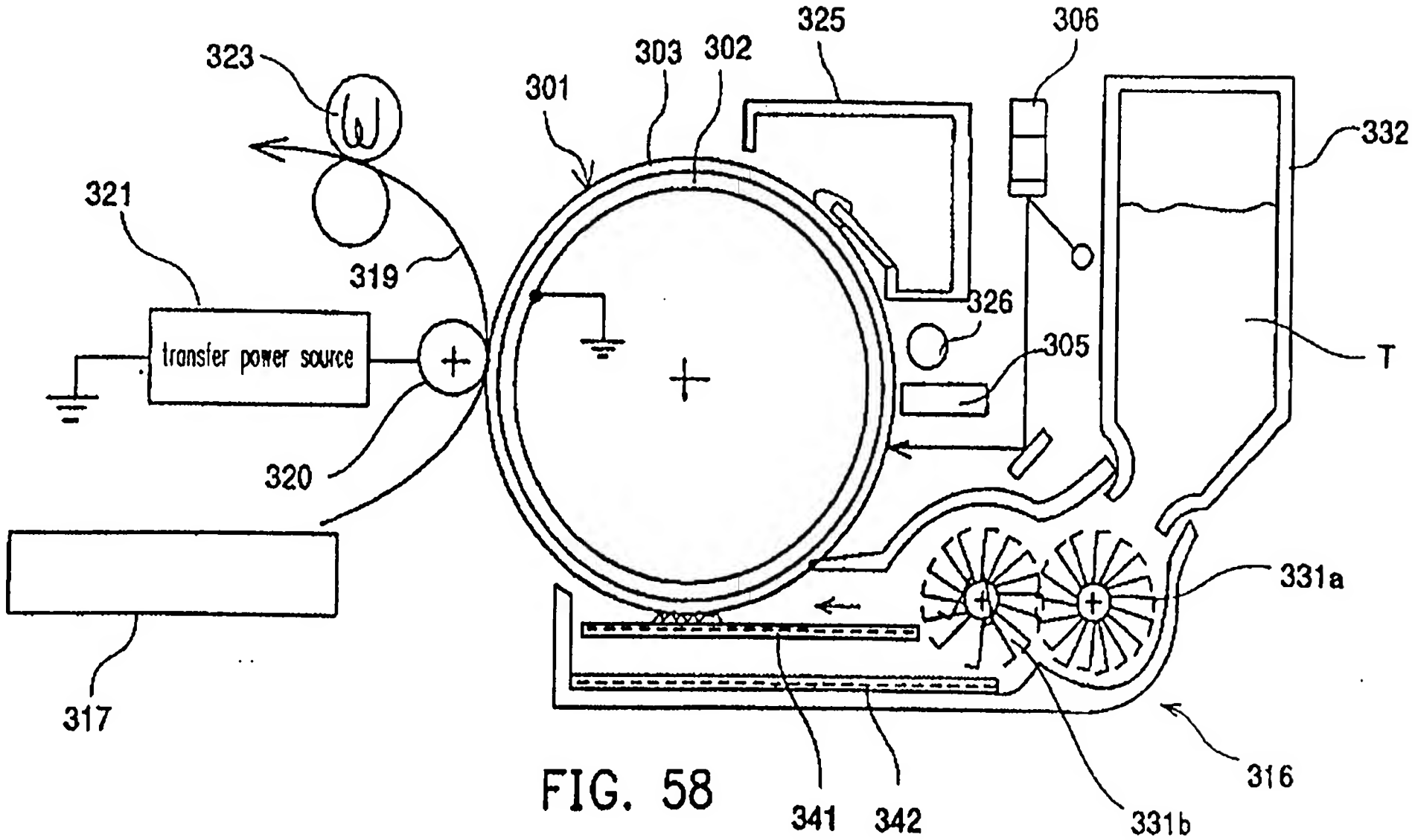

323
321
319
transfer power source
320
317
301
303
302
325
306
332
326
305
T
331a
331b
316
341
342

FIG. 58

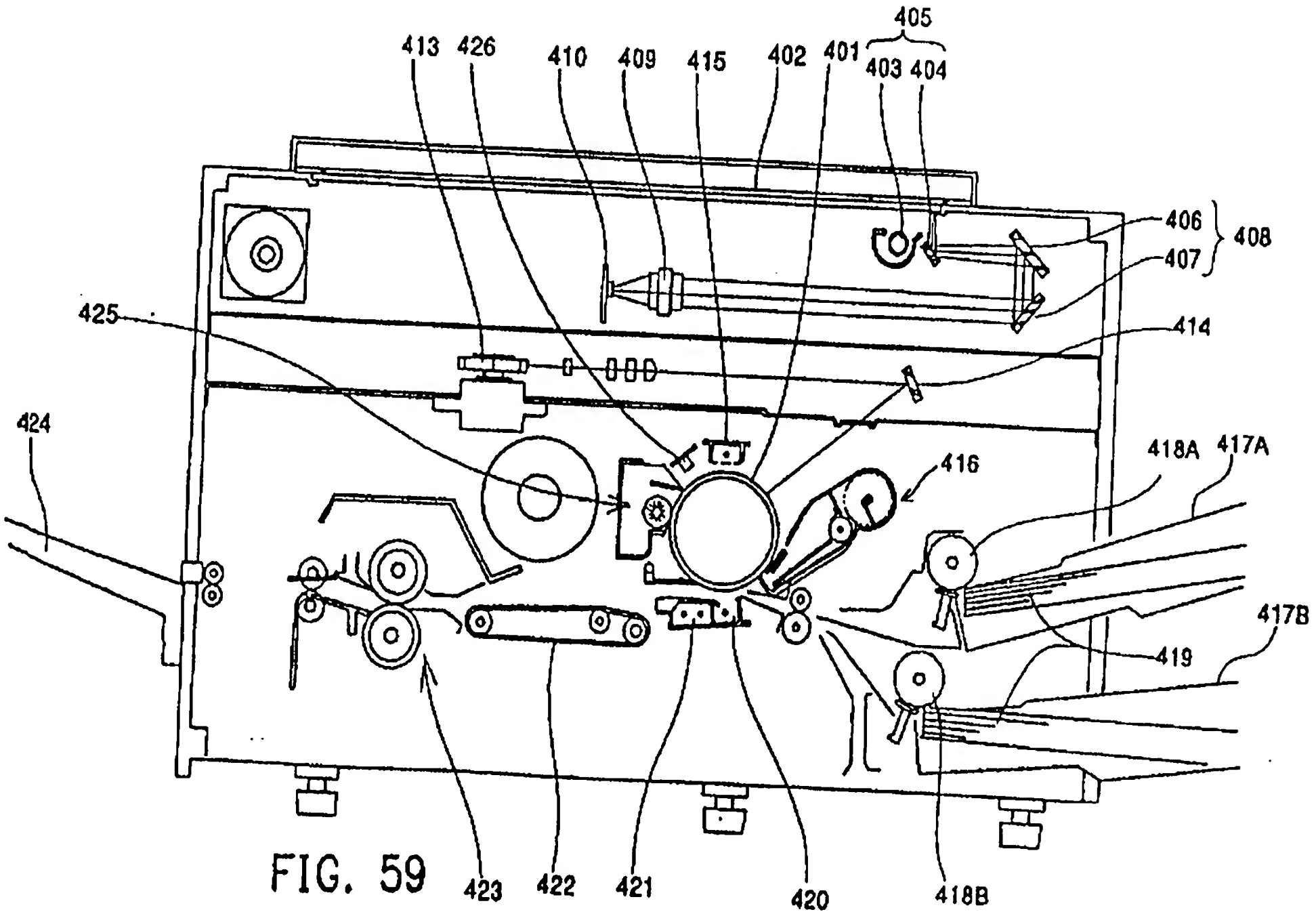

405
413
426
410
409
415
402
401
403
404
406
407
408
425
414
424
418A
417A
416
417B
419
423
422
421
420
418B

FIG. 59

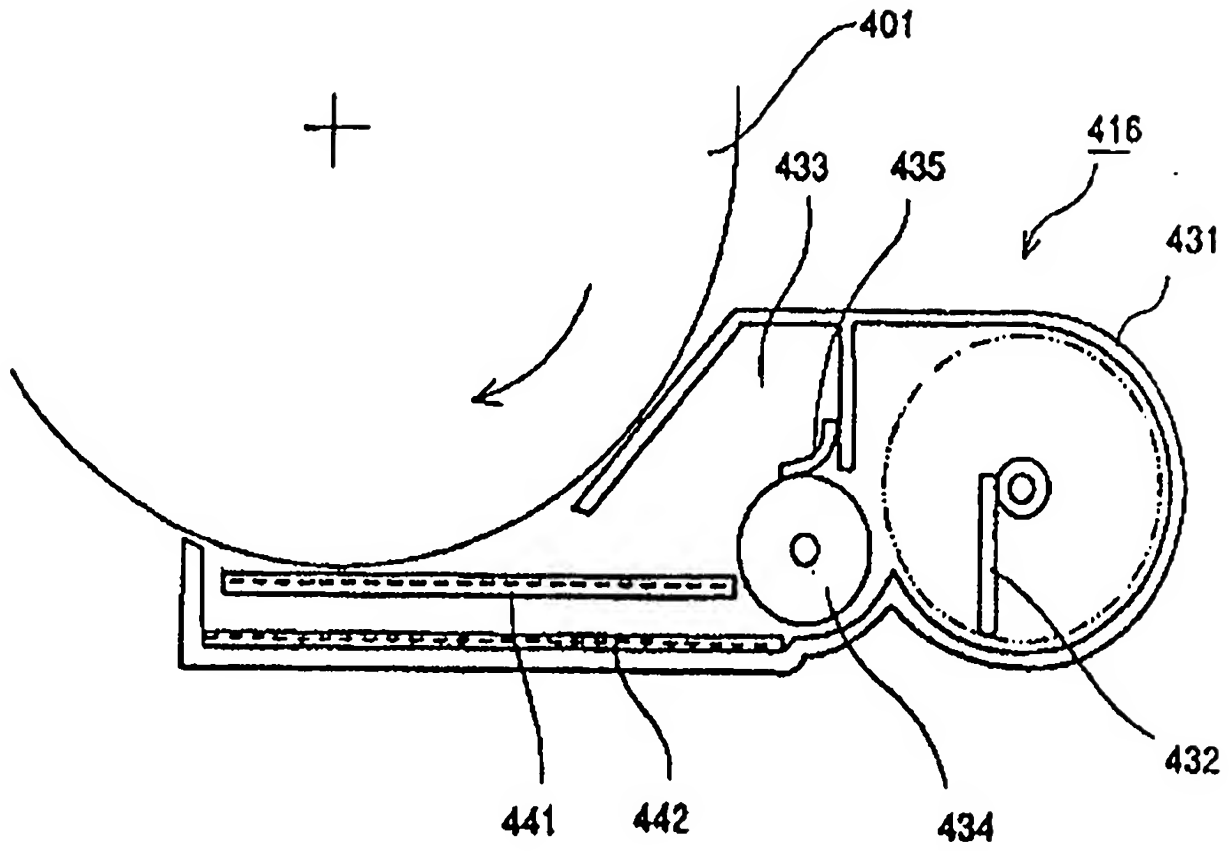


FIG. 60

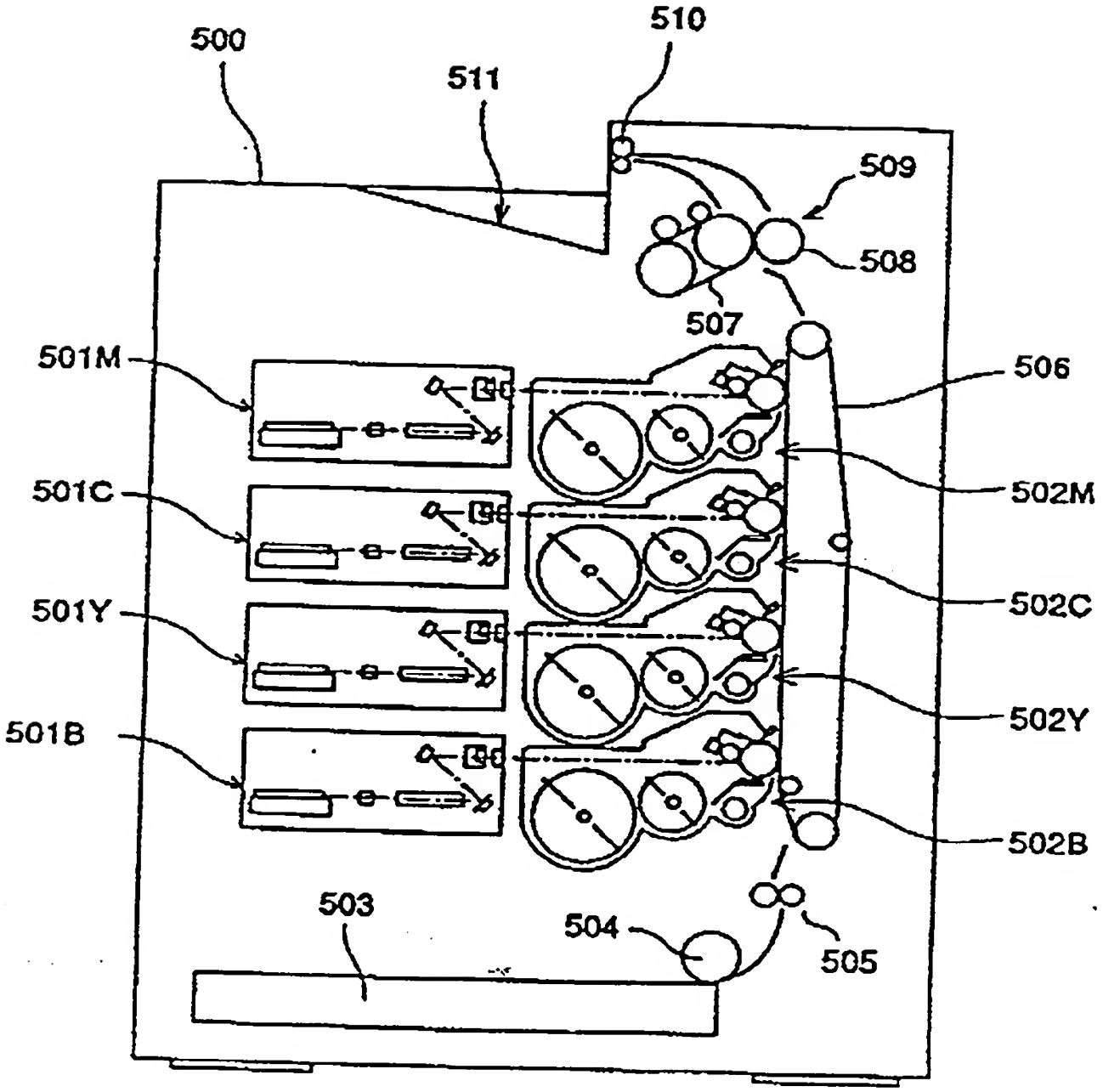

500
511
510
509
508
507
501M
501C
501Y
501B
506
502M
502C
502Y
502B
503
504
505

FIG. 61

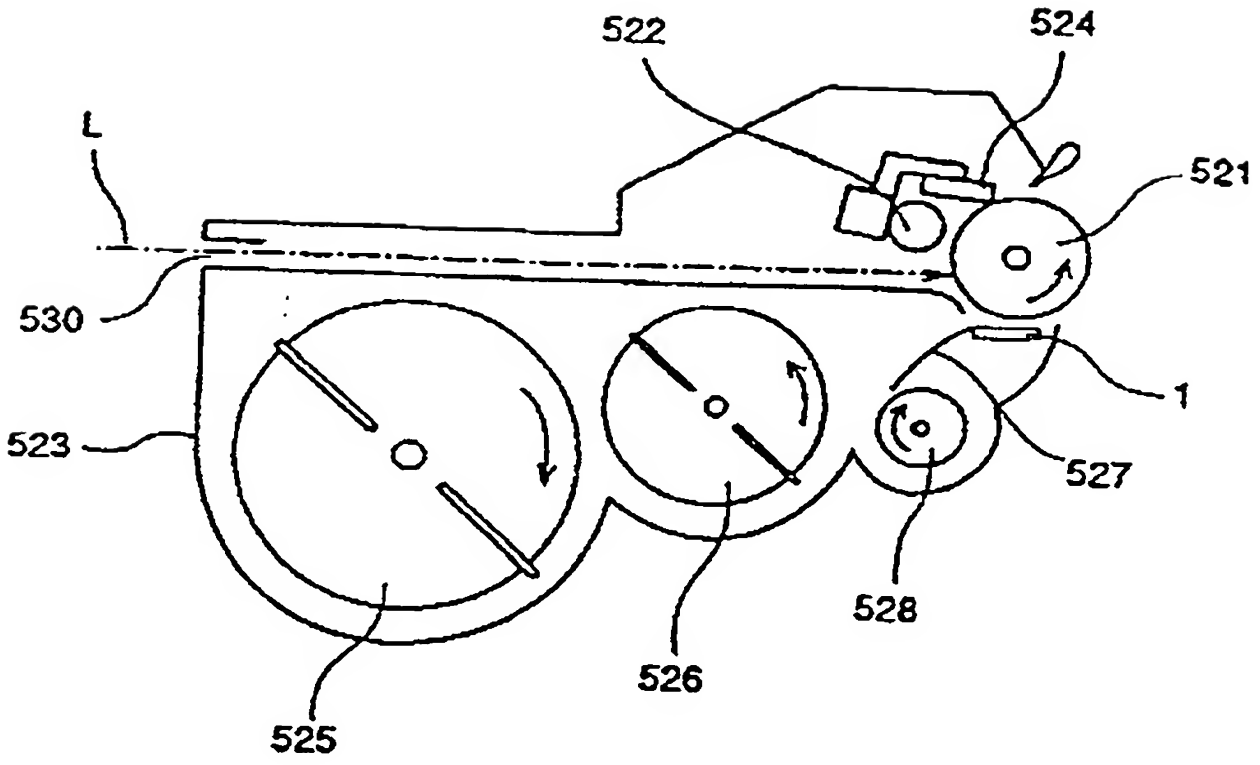

522
524
L
521
530
1
523
527
528
526
525

FIG. 62

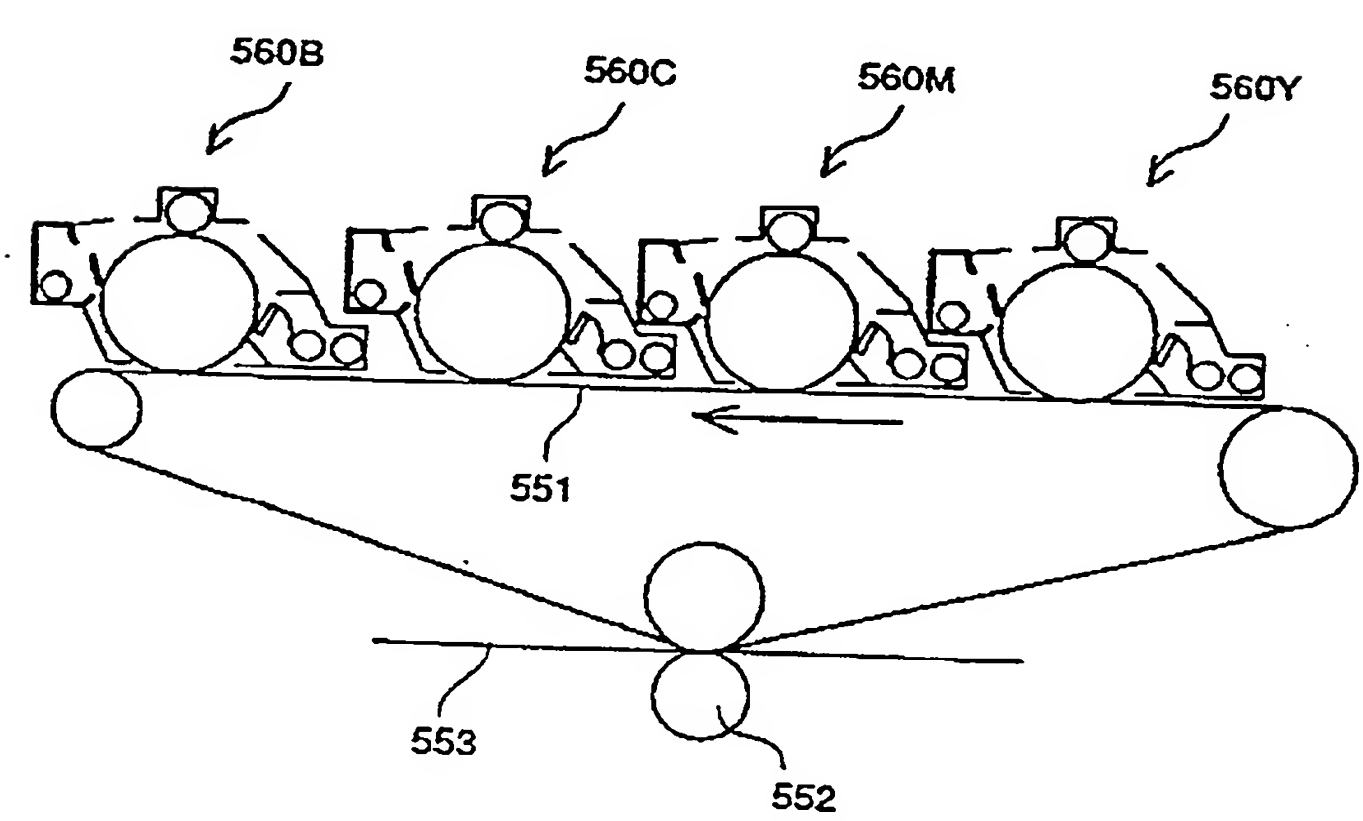

560B
560C
560M
560Y
551
553
552

FIG. 63

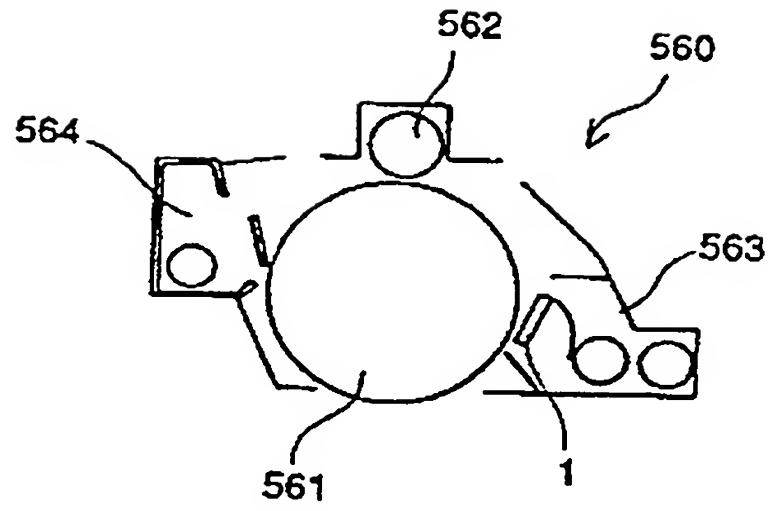


FIG. 64

WHAT IS CLAIMED IS:

1. A classifier for classifying a powder comprising:

a transfer member which has a plurality of electrodes for generating electric fields and which is configured to transport said powder while transferring and hopping said powder by an electrostatic force; and

an opposite member configured to selectively catch particles of said powder transferred and hopped by the transfer member, the opposite member being arranged in a position substantially opposite to the transfer member.

2. The classifier of claim1, wherein said opposite member is an opposite transfer member which has a plurality of electrodes for generating electric fields and which is configured to for transfer said powder by an electrostatic force.

3. The classifier of claim 2, wherein part or the whole of said opposite transfer member is inclined position against said transfer member.

4. The classifier of claim1, wherein said opposite member is a rotary roller member.

5. The classifier of claim1, wherein said opposite member is a rotary belt member.

6. The classifier of claim 5, wherein said belt member is inclined against said transfer member.

7. The classifier of claim1, wherein said opposite member comprises electrode wires.

8. The classifier of claim1, wherein said opposite member comprises an array of electrode wires.

9. The classifier of claim 8, wherein a voltage for generating electric fields is applied to each of the electrode wires.

10. The classifier of claim 7, wherein said each of the electrode wires is covered with a protective layer.

11. The classifier of claim 7, further comprising a slit member having slit holes arranged between the electrode wires, which are arranged at a position substantially opposite to said transfer member, and the transfer member.

12. The classifier of claim1, wherein said opposite member comprises a slit member having slit holes; and

electrodes formed on wall surfaces of the slit holes.

13. The classifier of claim 1, wherein a width of each of said

electrodes of said transfer member in a transporting direction of said powder is 1 to 20 times an average grain diameter of said powder, and each space between said electrodes in the transporting direction of said powder is 1 to 20 times the average grain diameter of said powder, wherein drive waveforms of n phases are applied to each of the plurality of electrodes, wherein n represents an integer not less than 3.

14. The classifier of claim 1, wherein said transfer member has an inorganic or organic surface protective layer covering said plurality of electrodes, and wherein a thickness of the surface protective layer is not more than 10 μ m.

15. The classifier of claim 1, wherein the classifier has a plurality of said opposite members, and the plurality of said opposite members selectively catch the particles of said powder depending on a quantity of charge or a mass of the particles of said powder.

16. A classifier for classifying powder, in which the classifier transports said powder while transferring and hopping the powder by an electrostatic force, comprising a member configured to selectively catch particles of said powder transferred and hopped by forming an electric field.

17. A developer, comprising:

a classifier configured to classify a powder; and

a developing means for developing a latent image on a latent image carrier the classified powder to form a visual image on the latent image carrier, and

wherein said classifier is the classifier of claim 1.

18. The developer of claim 17, wherein said developing means comprises a developing roller facing to said latent image carrier.

19. The developer of claim 18, wherein said developing roller also functions as said opposite member.

20. The developer of claim 17, wherein said developing means is a member having a plurality of electrodes for generating electric fields for transferring and hopping the powder by an electrostatic force at a position near said latent image carrier.

21. The developer of claim 20, wherein said member having a plurality of electrodes also functions as said opposite member.

22. The developer of claim 17, wherein said developer means comprises a rotary belt facing to said latent image carrier.

23. The developer of claim 22, wherein said rotary belt member also functions as said opposite member.

24. An image forming apparatus, comprising:

a latent image carrier; and

a developer configured to develop a latent image with a powder,

wherein the developer is the developer of claim 17.

ABSTRACT OF THE INVENTION

A classifier having a simple constitution for classifying powder with a high accuracy is provided. The classifier is provided with a transfer board having a plurality of electrodes for generating electric fields for transferring and hopping the powder by an electrostatic force. The classifier is further provided with an opposite roller generating an electric field for transporting and attaching the powder (toner) transferred and hopped on the transfer board to the opposite roller, which is opposite to the transfer board.

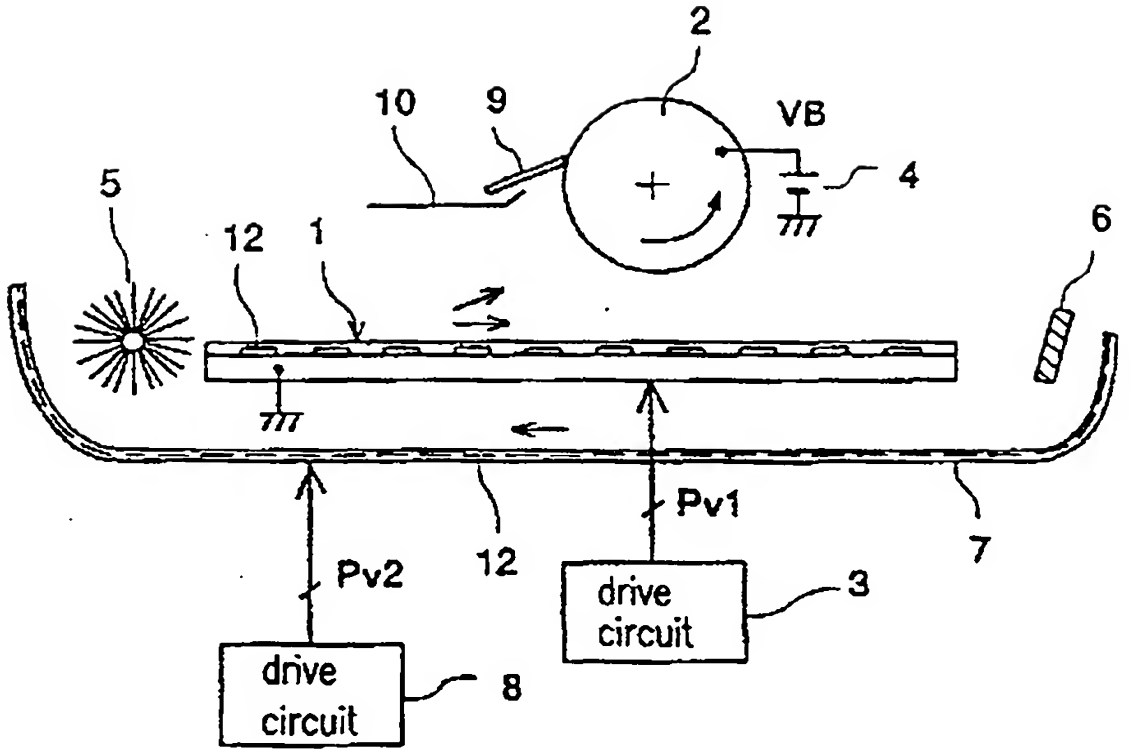

2
10
9
VB
4
5
12
1
6
Pv1
Pv2
12
7
drive circuit
3
drive circuit
8

FIG. 1

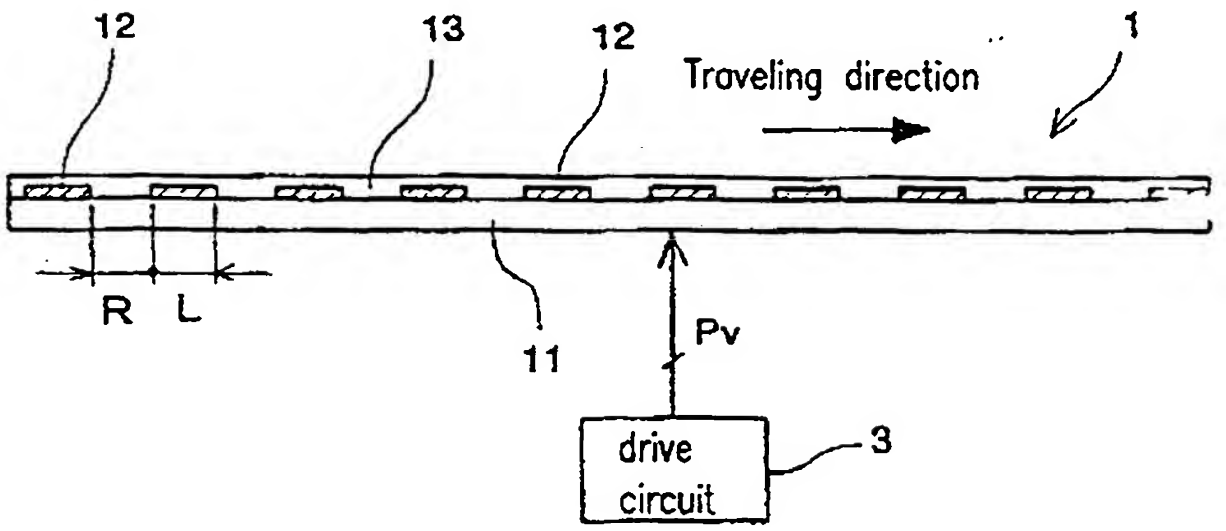

12
13
12
1
Traveling direction
R
L
11
Pv
drive circuit
3

FIG. 2

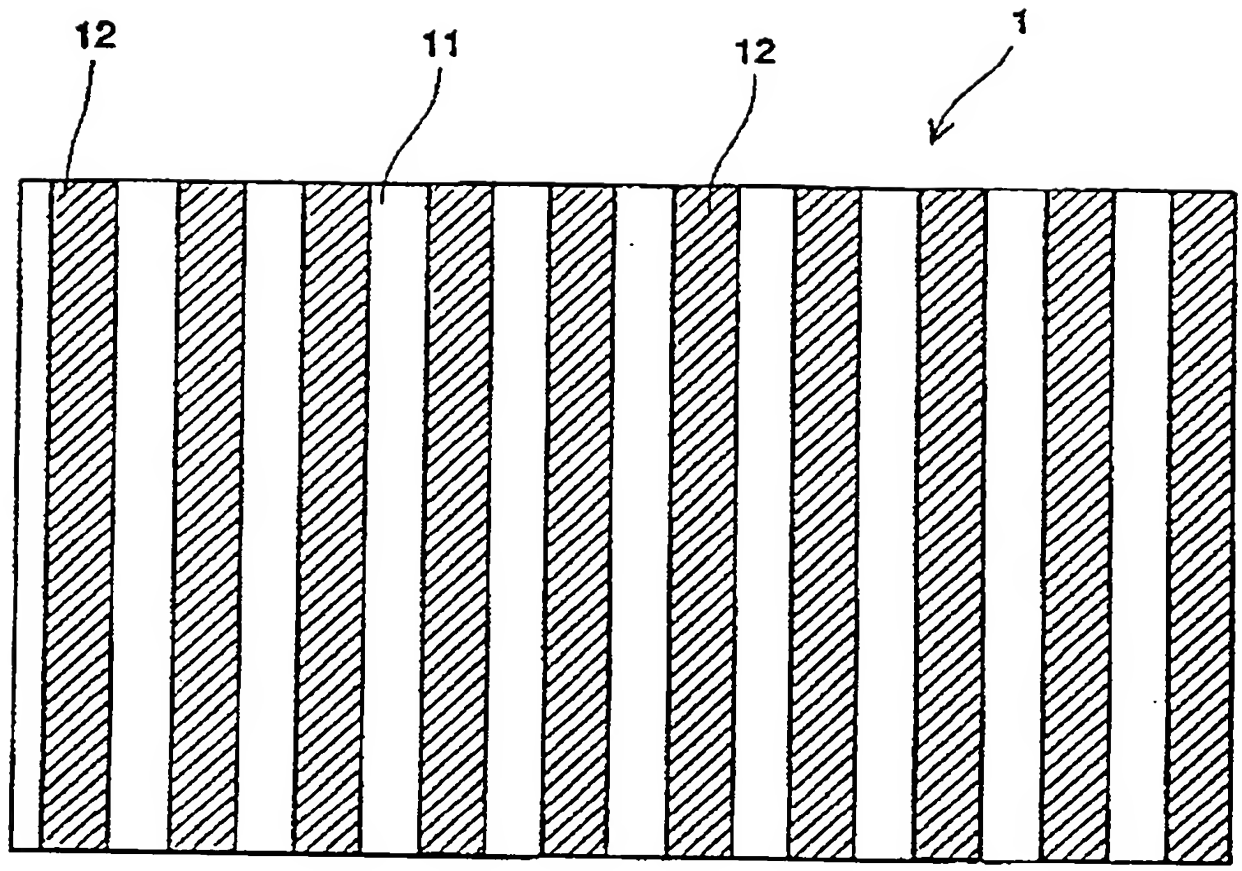


FIG. 3

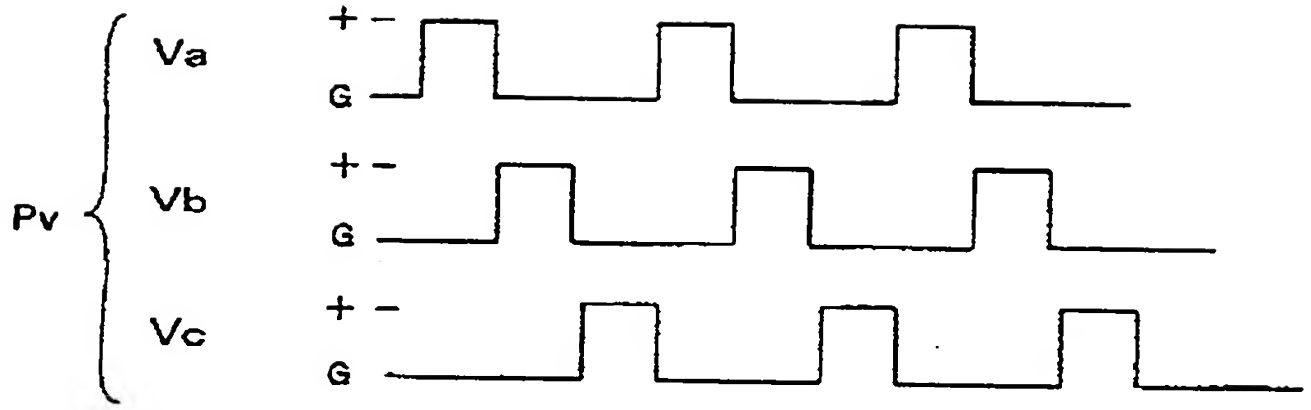

Pv
Va
Vb
Vc
+ −
G

FIG. 4

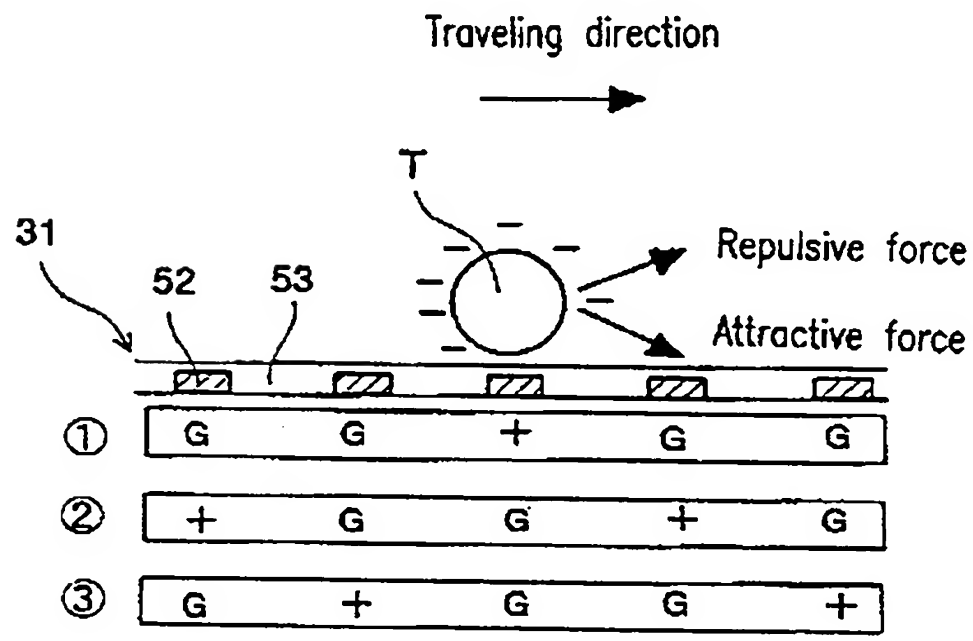

Traveling direction
T
31
52
53
Repulsive force
Attractive force
①
②
③
G
+

FIG. 5

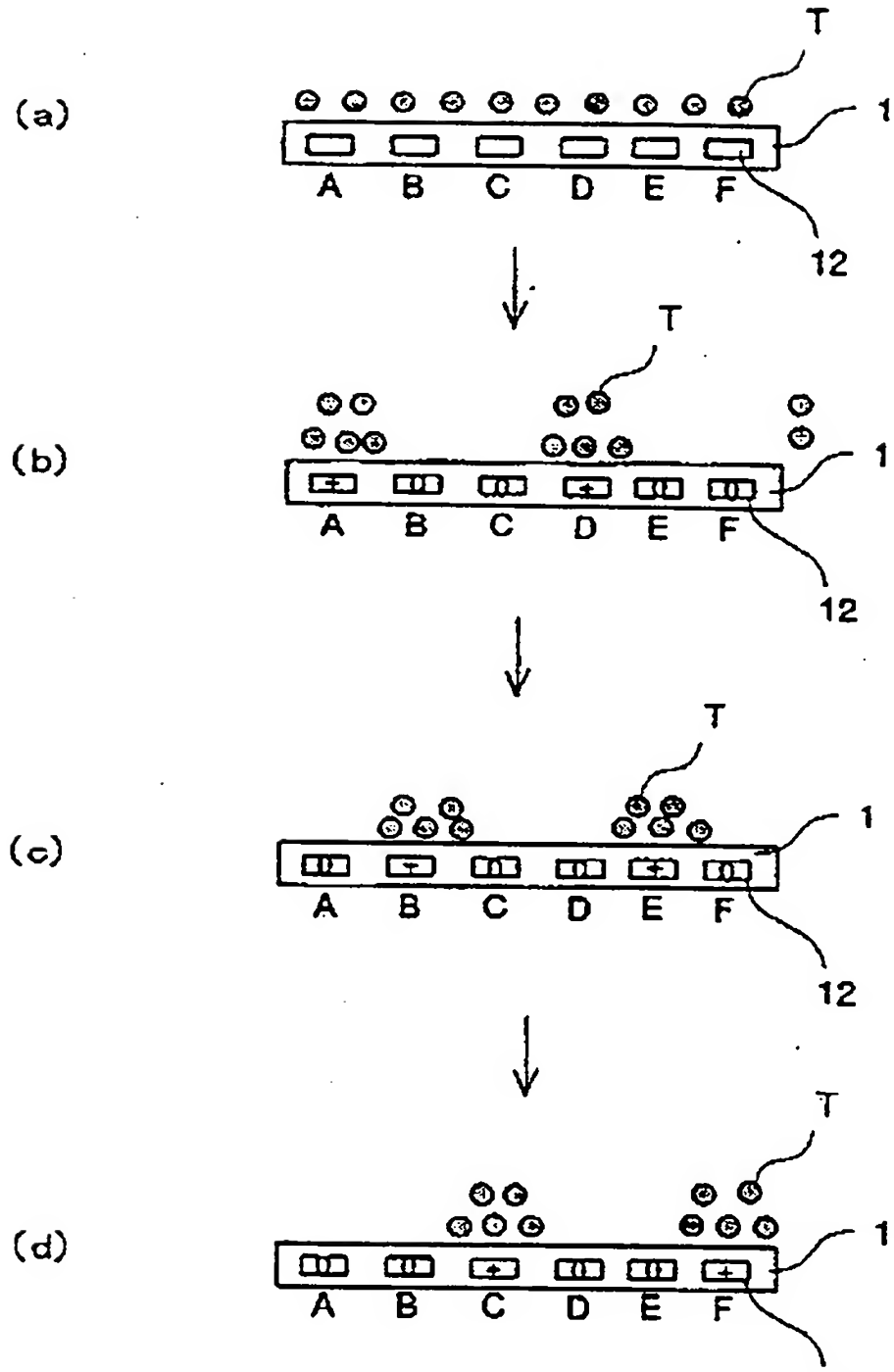


FIG. 6

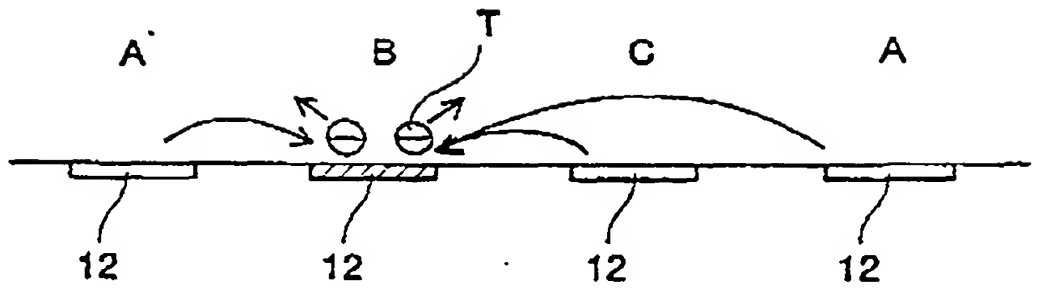


FIG. 7

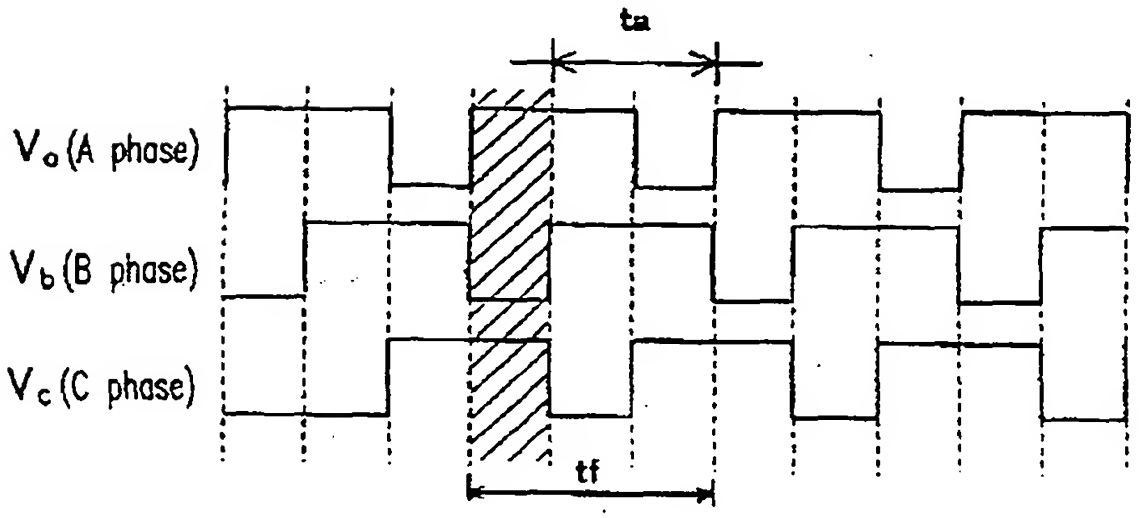


FIG. 8

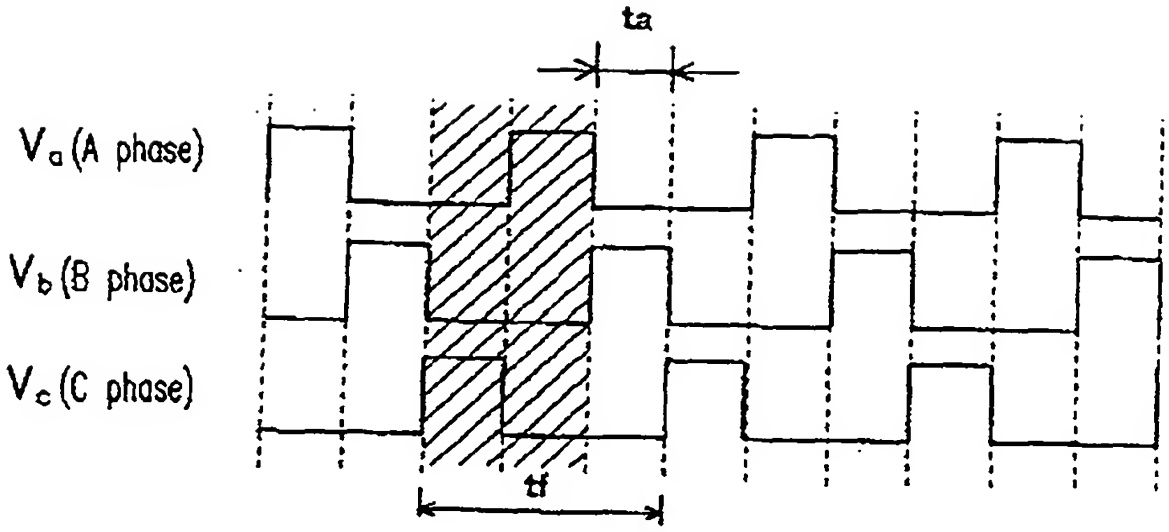

ta
V_a (A phase)
V_b (B phase)
V_c (C phase)
tf

FIG. 9

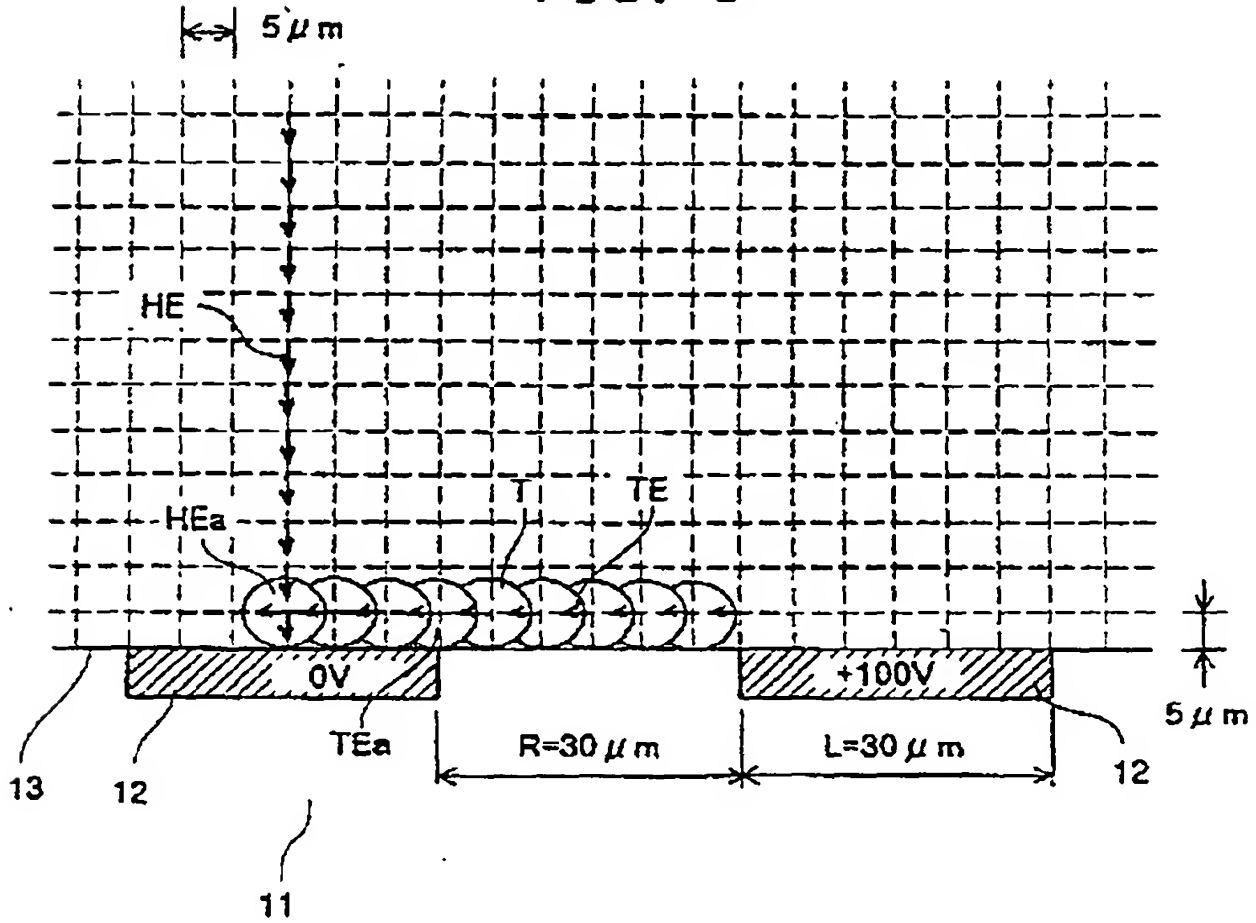

5 μm
HE
HEa
TE
0V
+100V
5 μm
TEa
R=30 μm
L=30 μm
13
12
12
11

FIG. 10

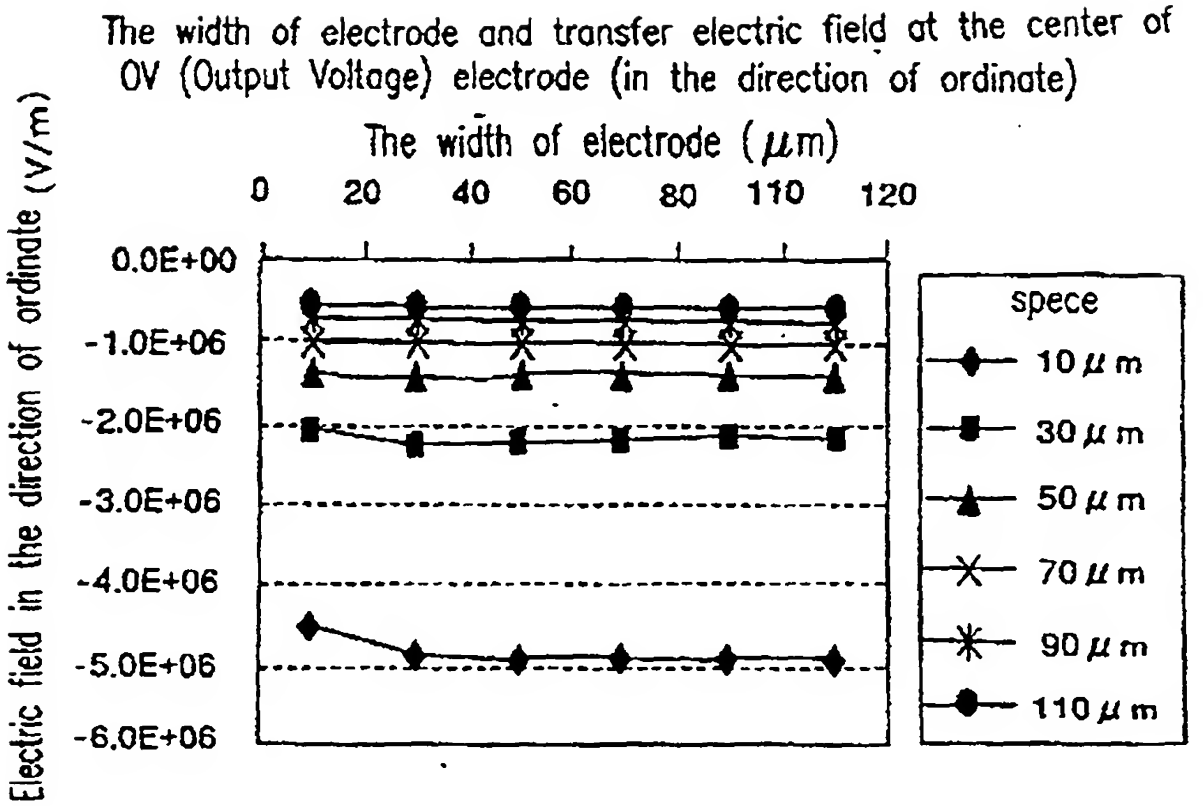

The width of electrode and transfer electric field at the center of OV (Output Voltage) electrode (in the direction of ordinate)
The width of electrode (μm)
0
20
40
60
80
110
120
Electric field in the direction of ordinate (V/m)
0.0E+00
-1.0E+06
-2.0E+06
-3.0E+06
-4.0E+06
-5.0E+06
-6.0E+06
spece
10 μm
30 μm
50 μm
70 μm
90 μm
110 μm

FIG. 11

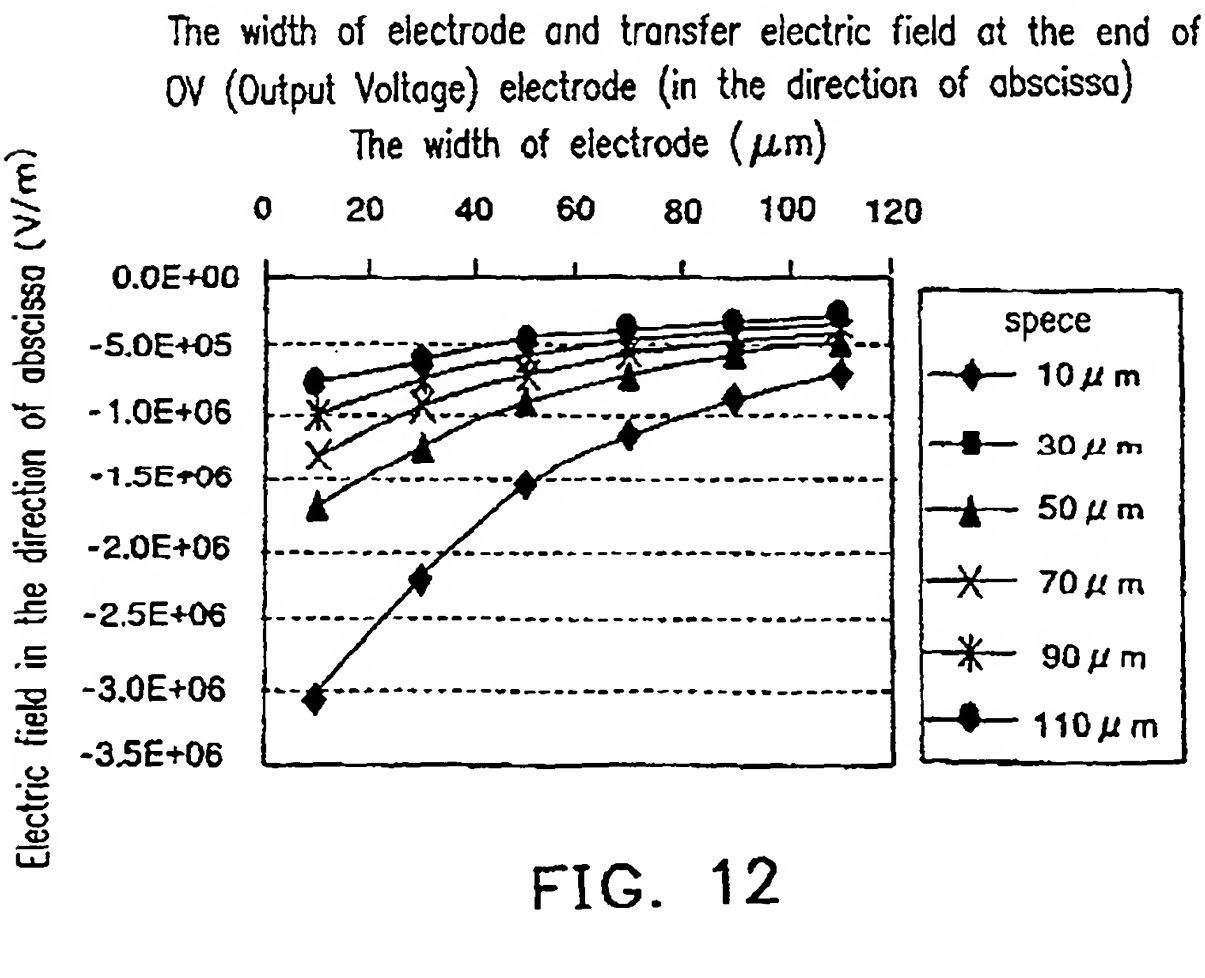

The width of electrode and transfer electric field at the end of OV (Output Voltage) electrode (in the direction of abscissa)
The width of electrode (μm)
0
20
40
60
80
100
120
Electric field in the direction of abscissa (V/m)
0.0E+00
-5.0E+05
-1.0E+06
-1.5E+06
-2.0E+06
-2.5E+06
-3.0E+06
-3.5E+06
spece
10 μm
30 μm
50 μm
70 μm
90 μm
110 μm

FIG. 12

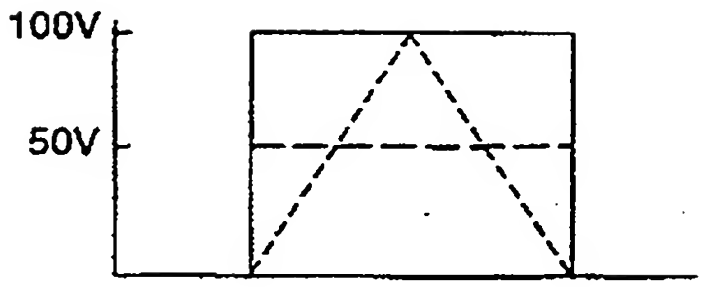

100V
50V

FIG. 13

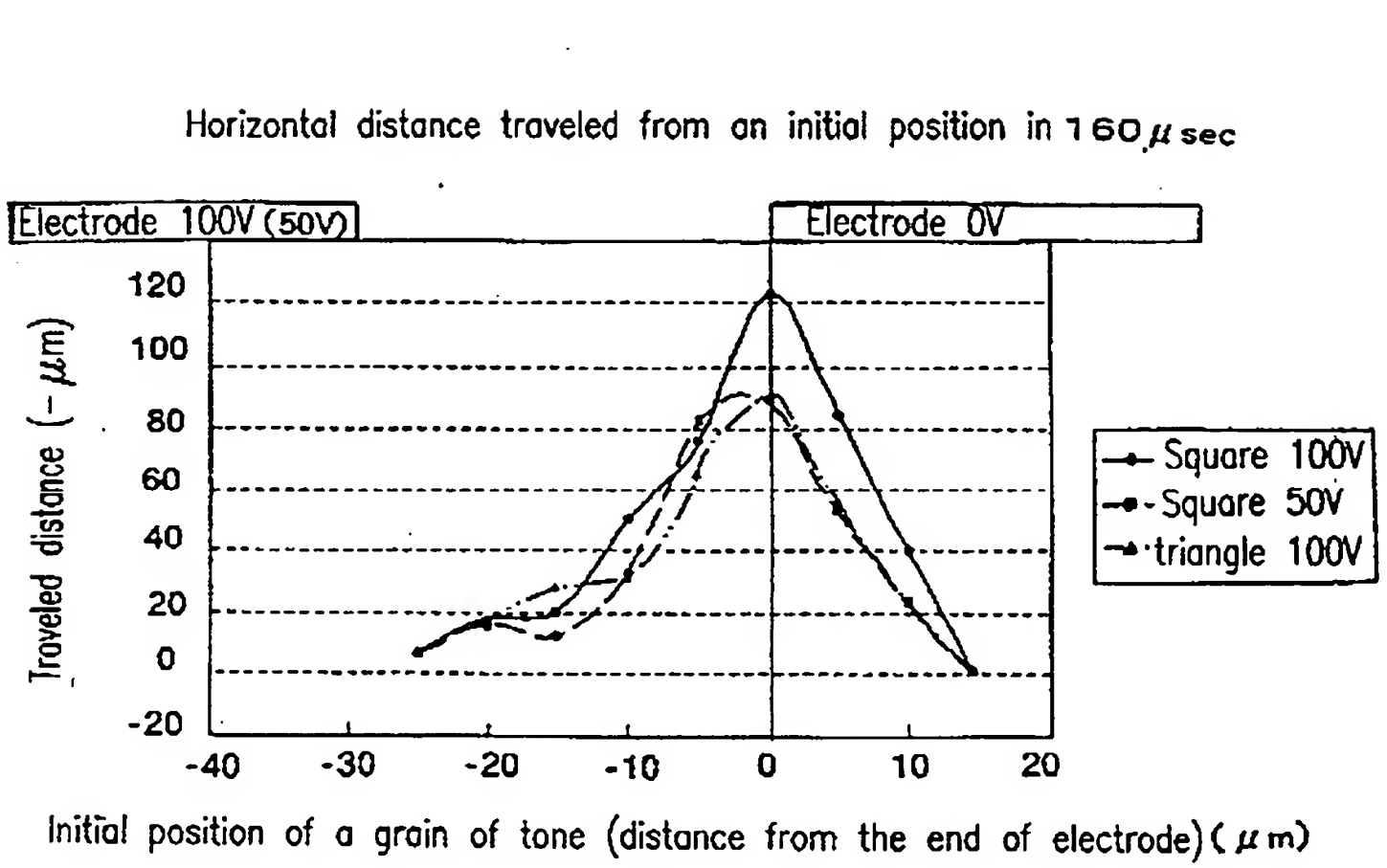

Horizontal distance traveled from an initial position in 160 μ sec
Electrode 100V (50V)
Electrode 0V
Traveled distance (- μm)
120
100
80
60
40
20
0
-20
-40
-30
-20
-10
0
10
20
Square 100V
Square 50V
triangle 100V
Initial position of a grain of tone (distance from the end of electrode) (μ m)

FIG. 14

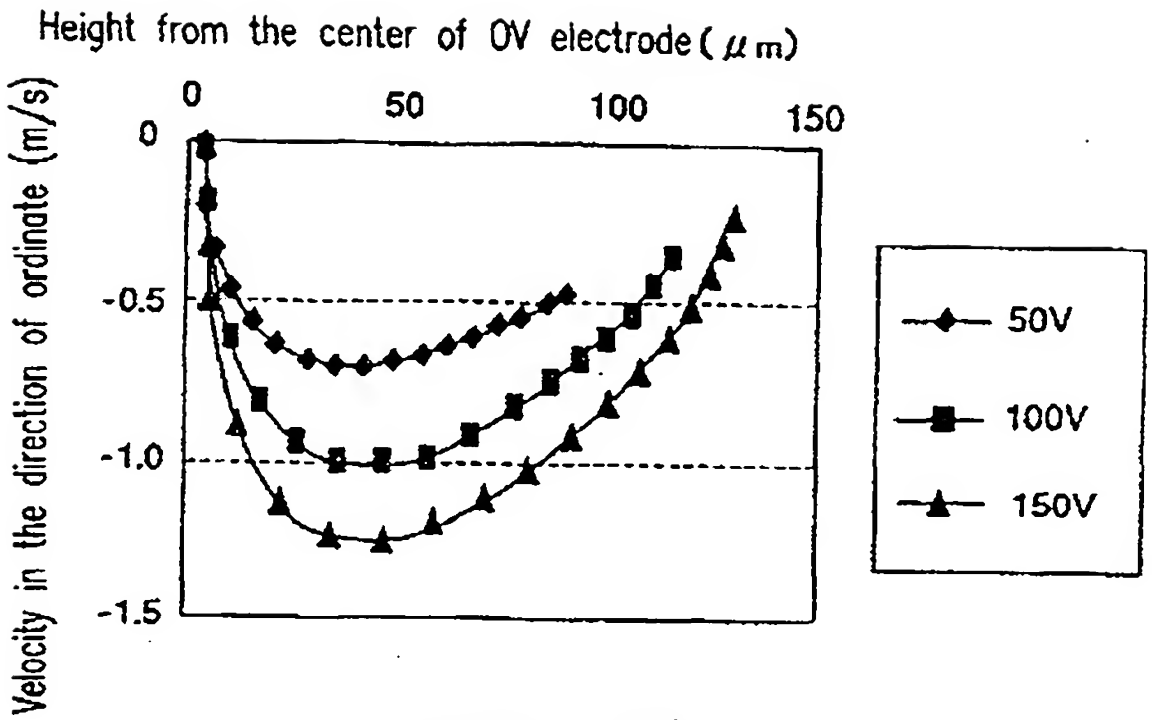


FIG. 15

Protective layer film and transfer electric field

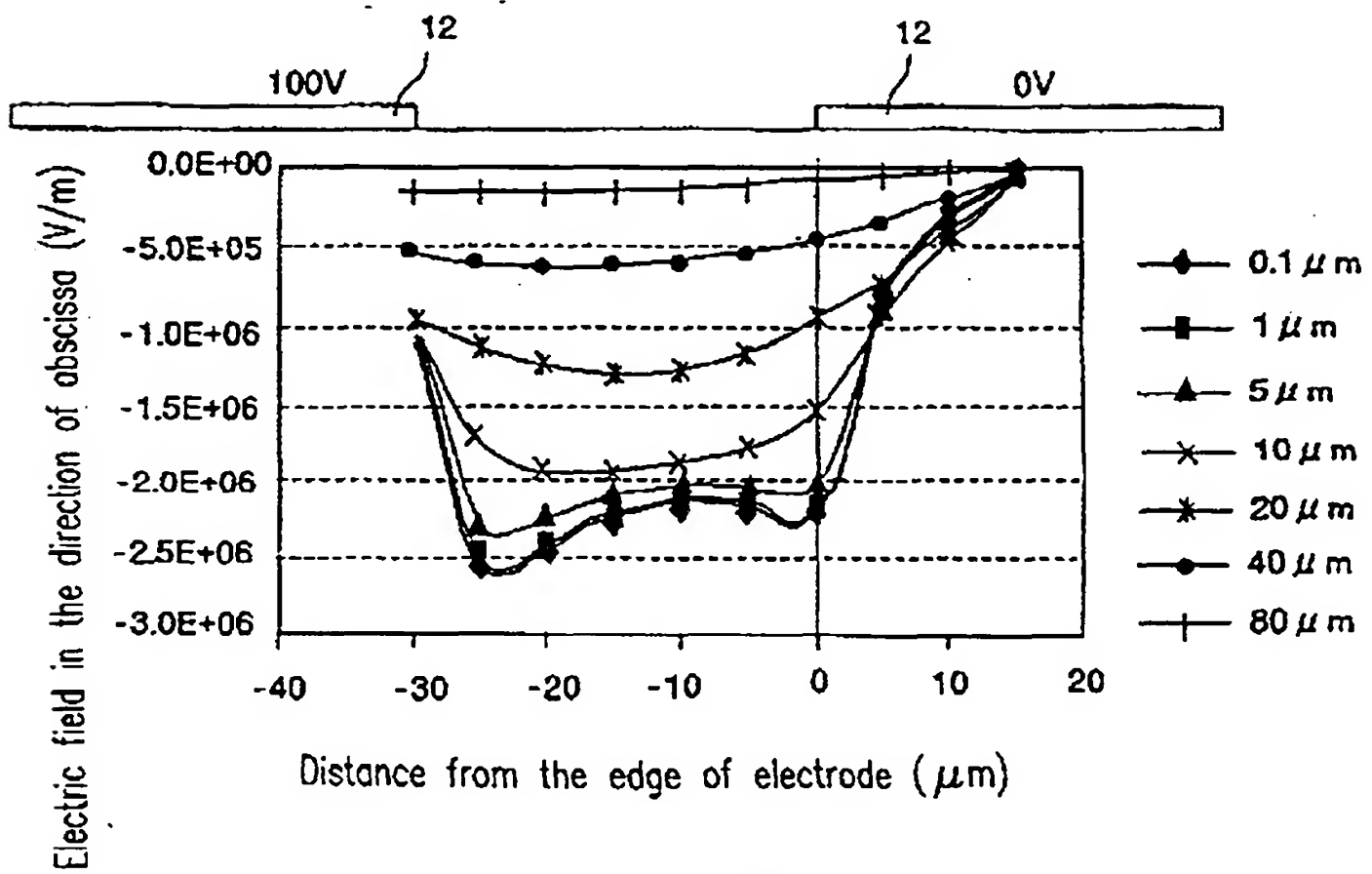


FIG. 16

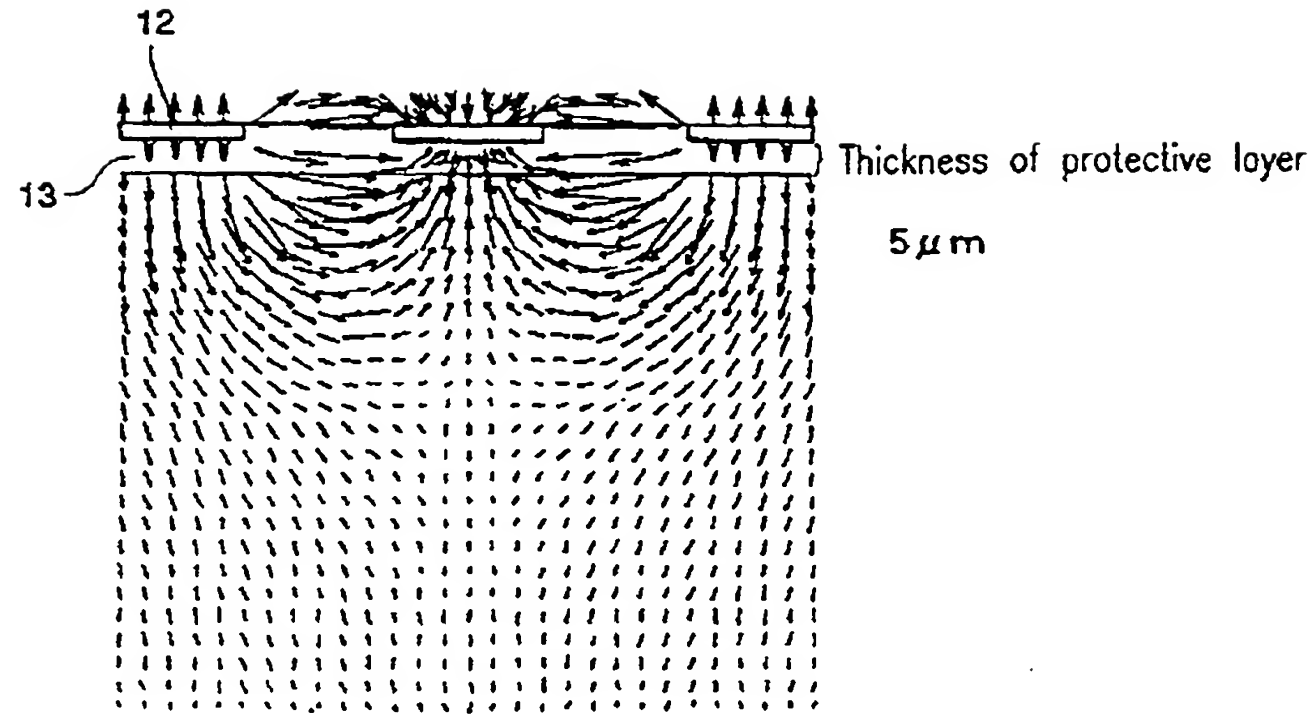

12
13
Thickness of protective layer
5 μm

FIG. 17

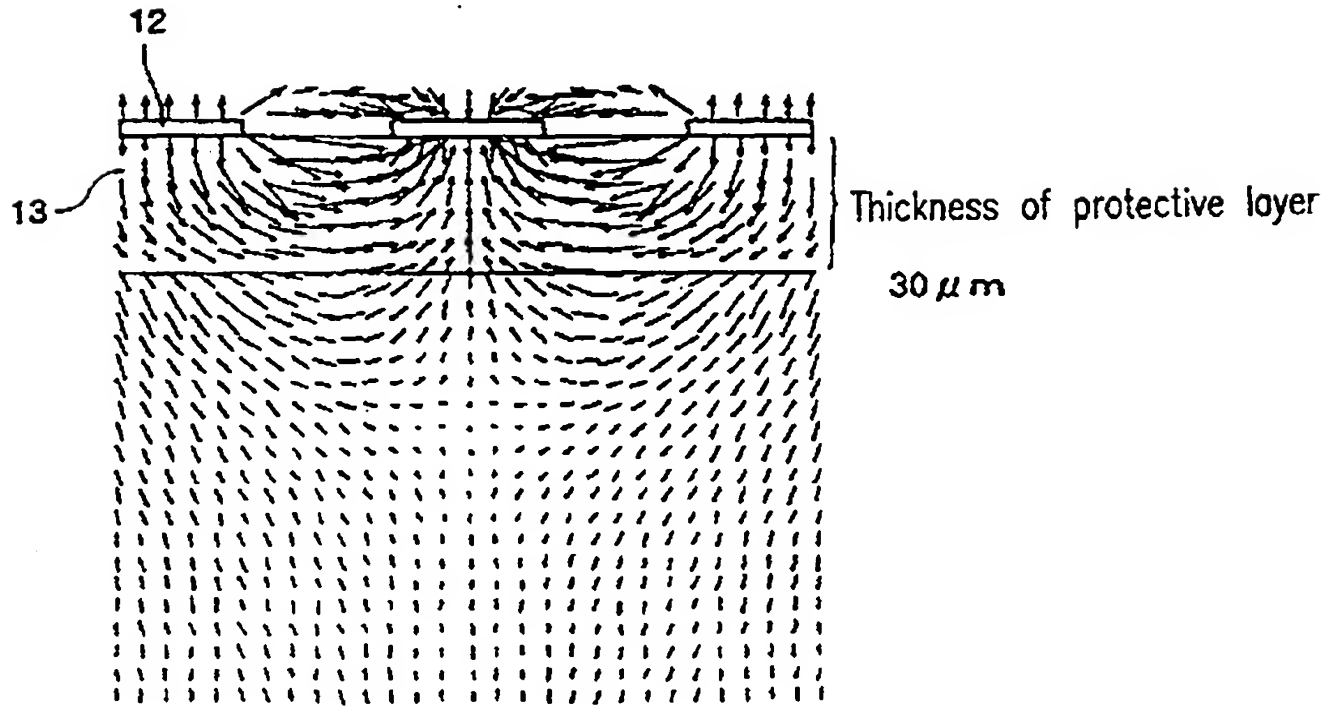

12
13
Thickness of protective layer
30 μm

FIG. 18

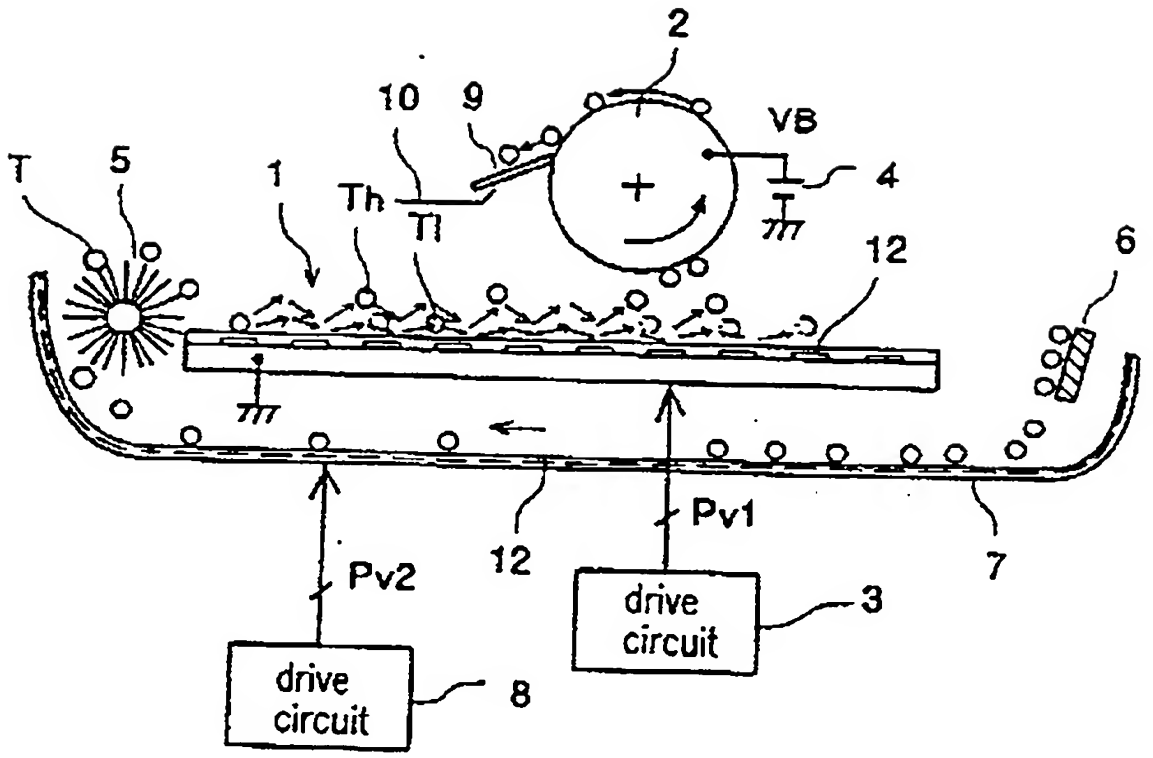

2
10
9
VB
T
5
1
Th
Tl
4
12
6
Pv1
Pv2
12
7
drive circuit
3
drive circuit
8

FIG. 19

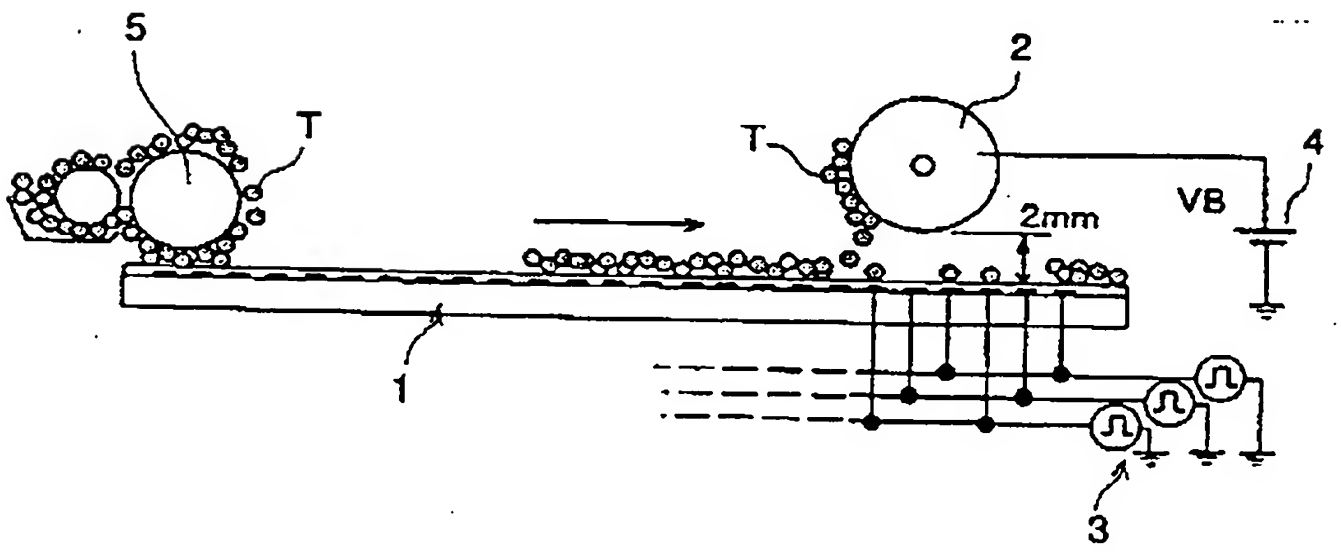

5
T
2
T
4
VB
2mm
1
3

FIG. 20

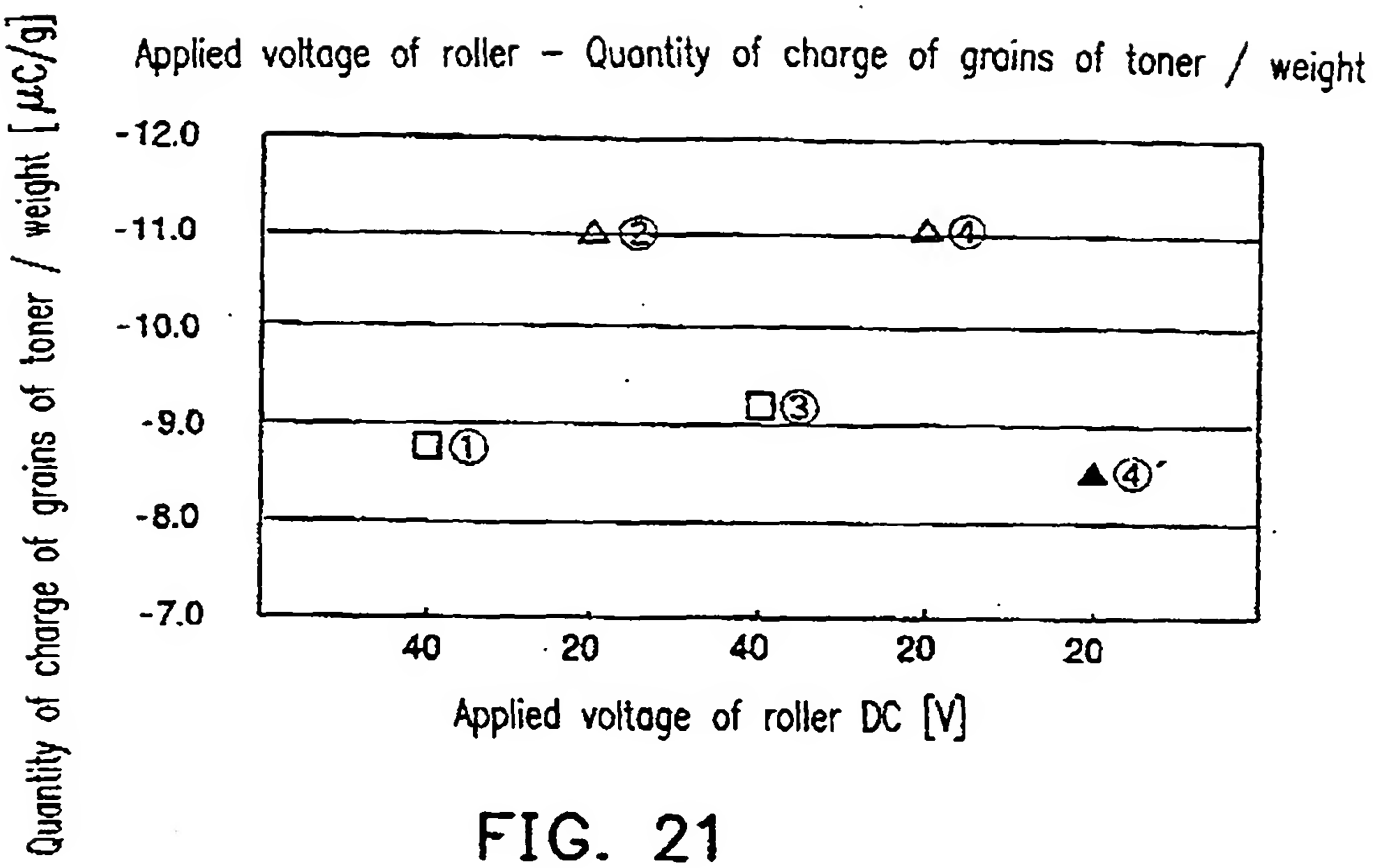

Applied voltage of roller – Quantity of charge of grains of toner / weight
Quantity of charge of grains of toner / weight [μC/g]
-12.0
-11.0
-10.0
-9.0
-8.0
-7.0
②
④
③
①
④'
40
20
40
20
20
Applied voltage of roller DC [V]

FIG. 21

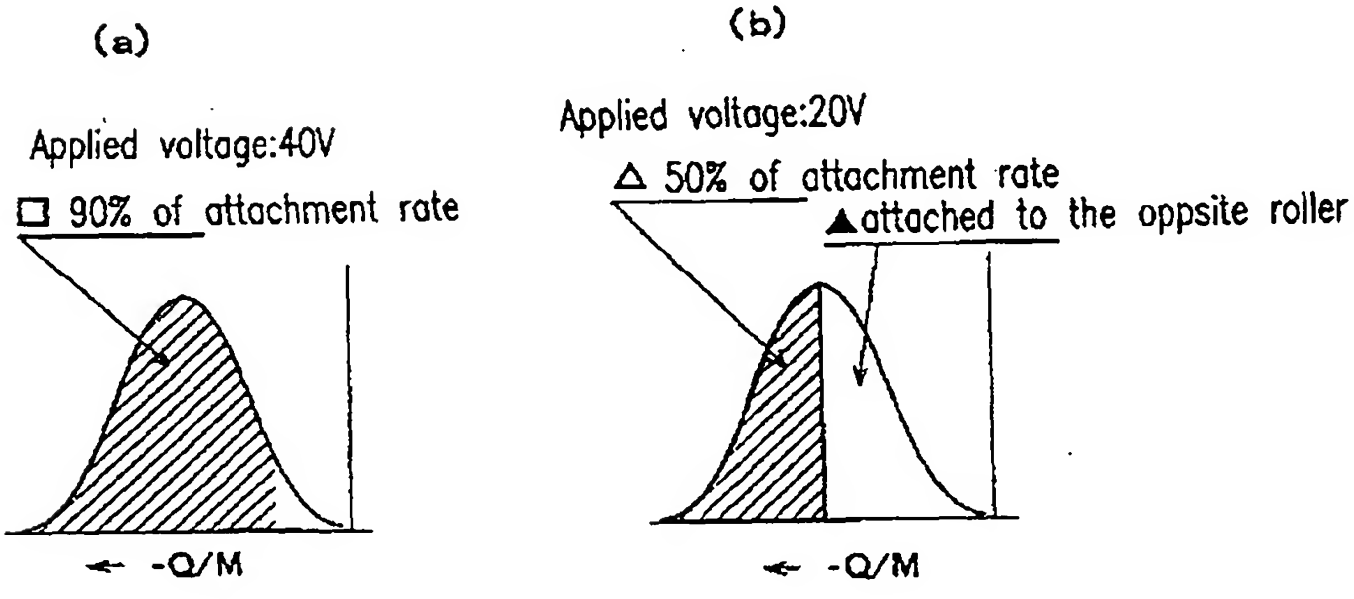

(a)
Applied voltage:40V
□ 90% of attachment rate
← -Q/M
(b)
Applied voltage:20V
△ 50% of attachment rate
▲attached to the oppsite roller
← -Q/M

FIG. 22

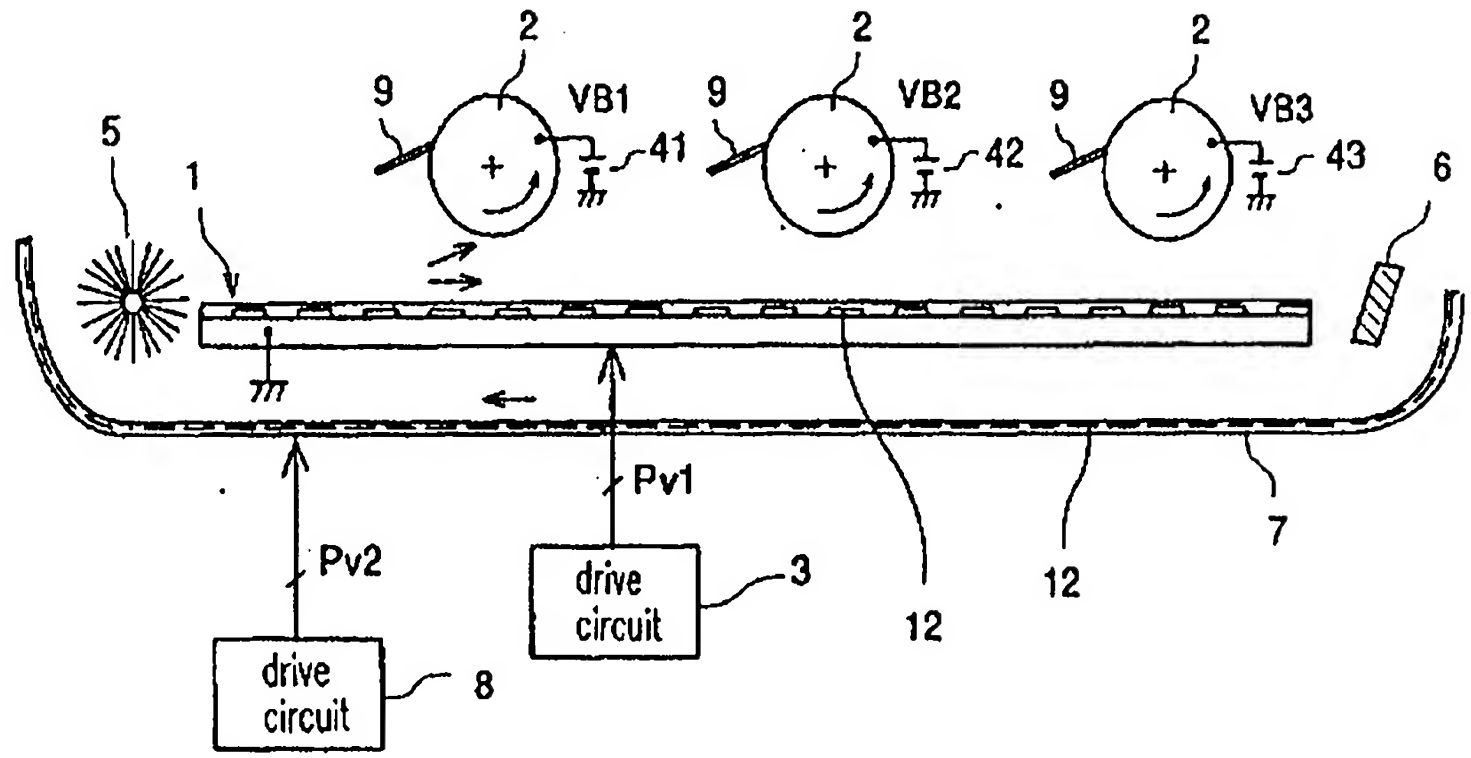

2
2
2
9
VB1
9
VB2
9
VB3
5
41
42
43
6
1
Pv1
Pv2
drive circuit
3
drive circuit
8
12
12
7

FIG. 23

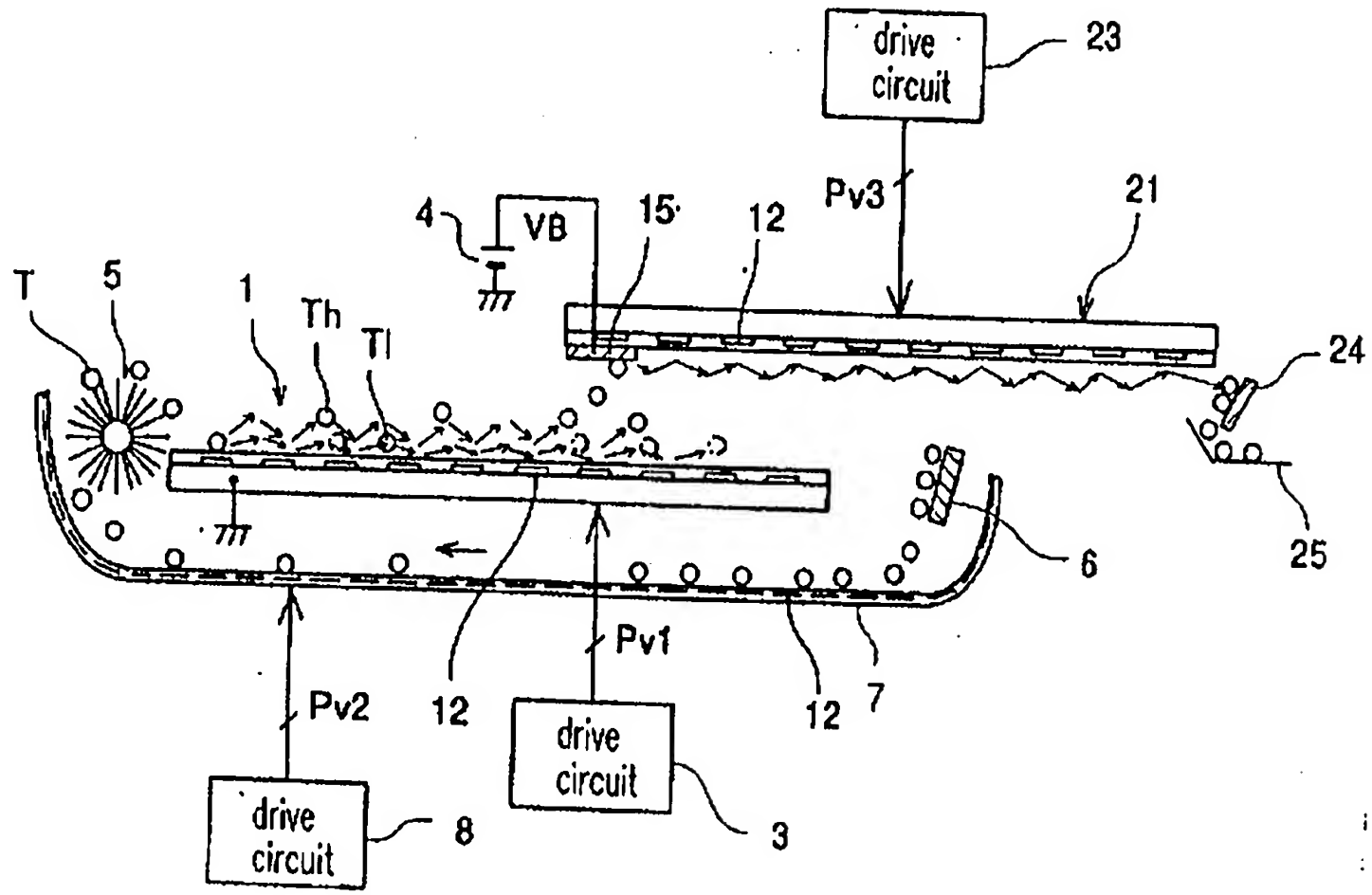

drive circuit
23
Pv3
21
4
VB
15
12
T
5
1
Th
Tl
24
25
6
Pv1
Pv2
12
12
7
drive circuit
drive circuit
8
3

FIG. 24

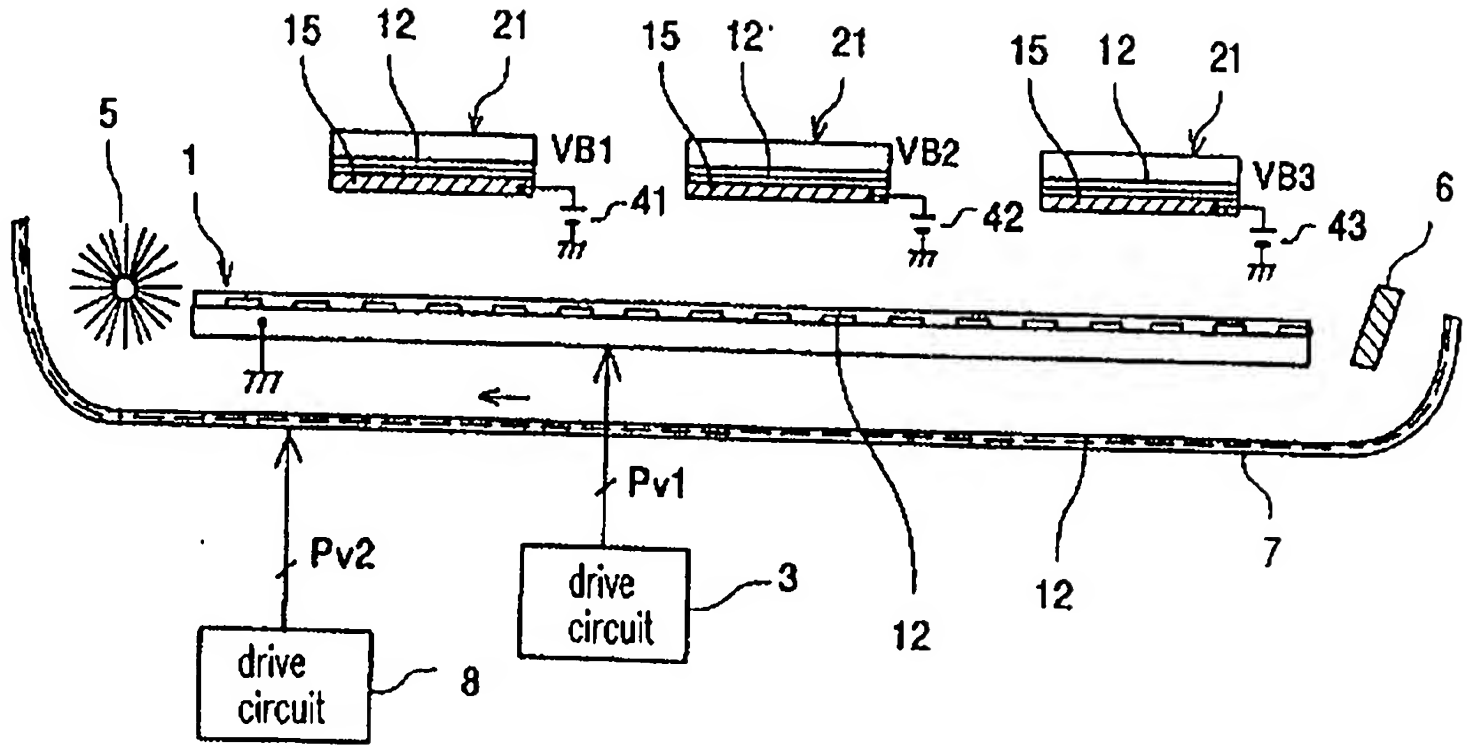

15
12
21
VB1
41
15
12
21
VB2
42
15
12
21
VB3
43
5
1
6
Pv1
Pv2
drive circuit
8
drive circuit
3
12
12
7

FIG. 25

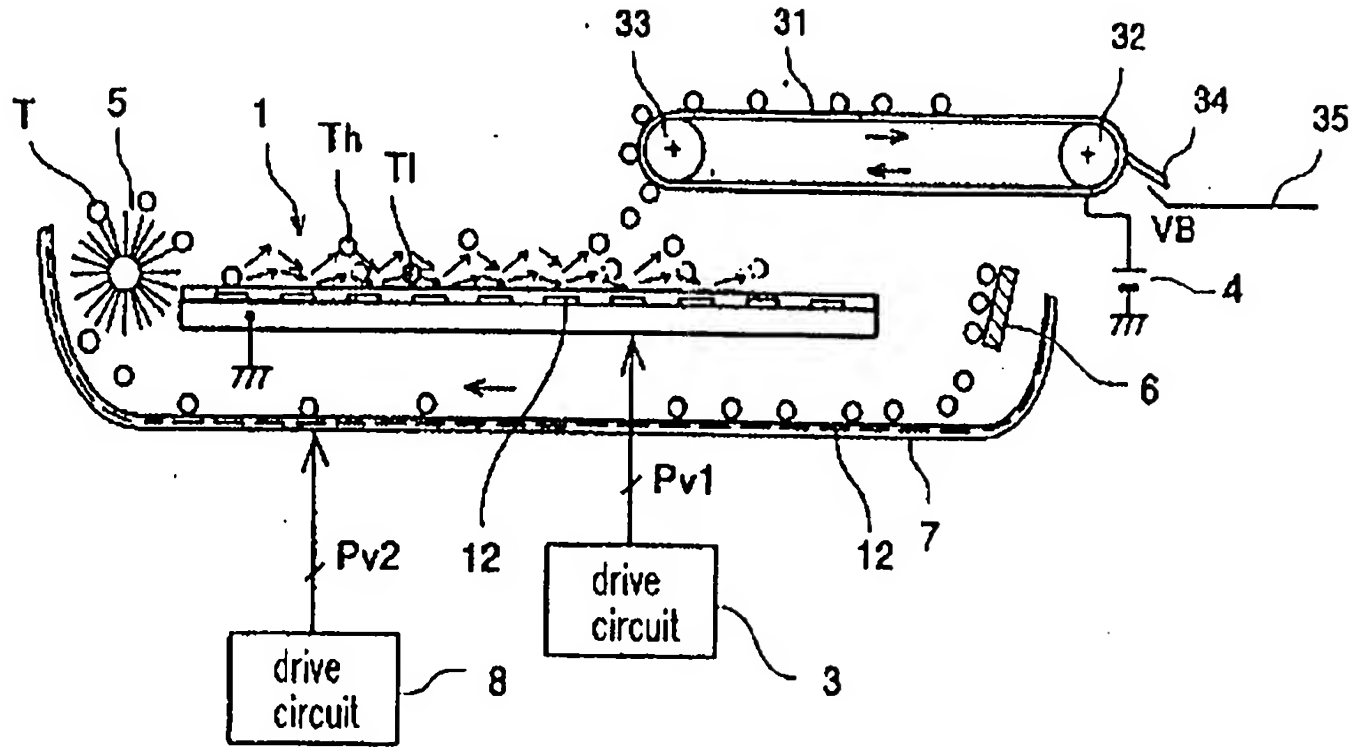

T
5
1
Th
Tl
33
31
32
34
35
VB
4
6
Pv1
Pv2
12
12
7
drive circuit
8
drive circuit
3

FIG. 26

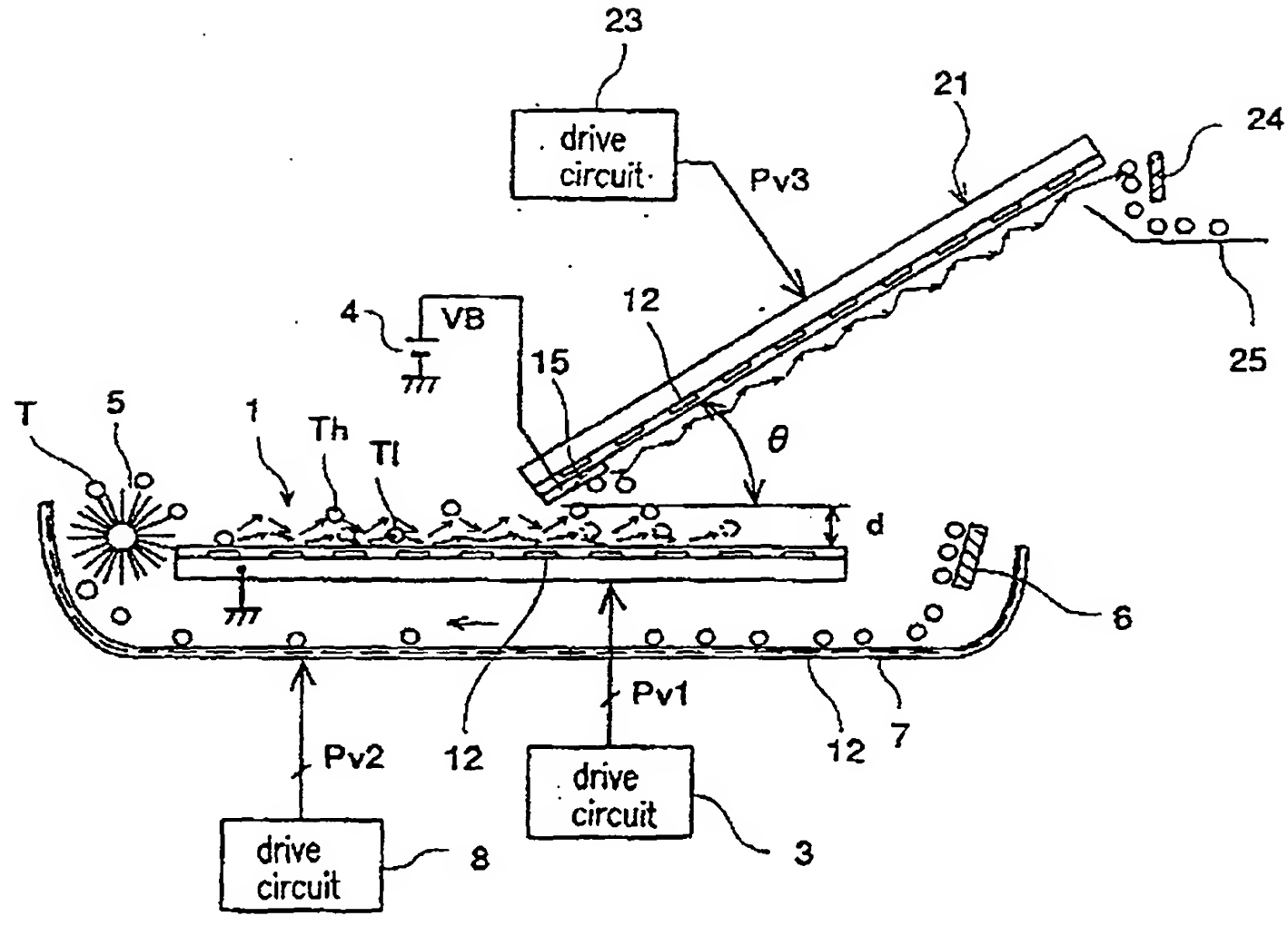

23
drive
circuit
Pv3
21
24
25
4
VB
12
15
T
5
1
Th
Tl
θ
d
6
Pv1
Pv2
12
12
7
drive
circuit
3
drive
circuit
8

FIG. 27

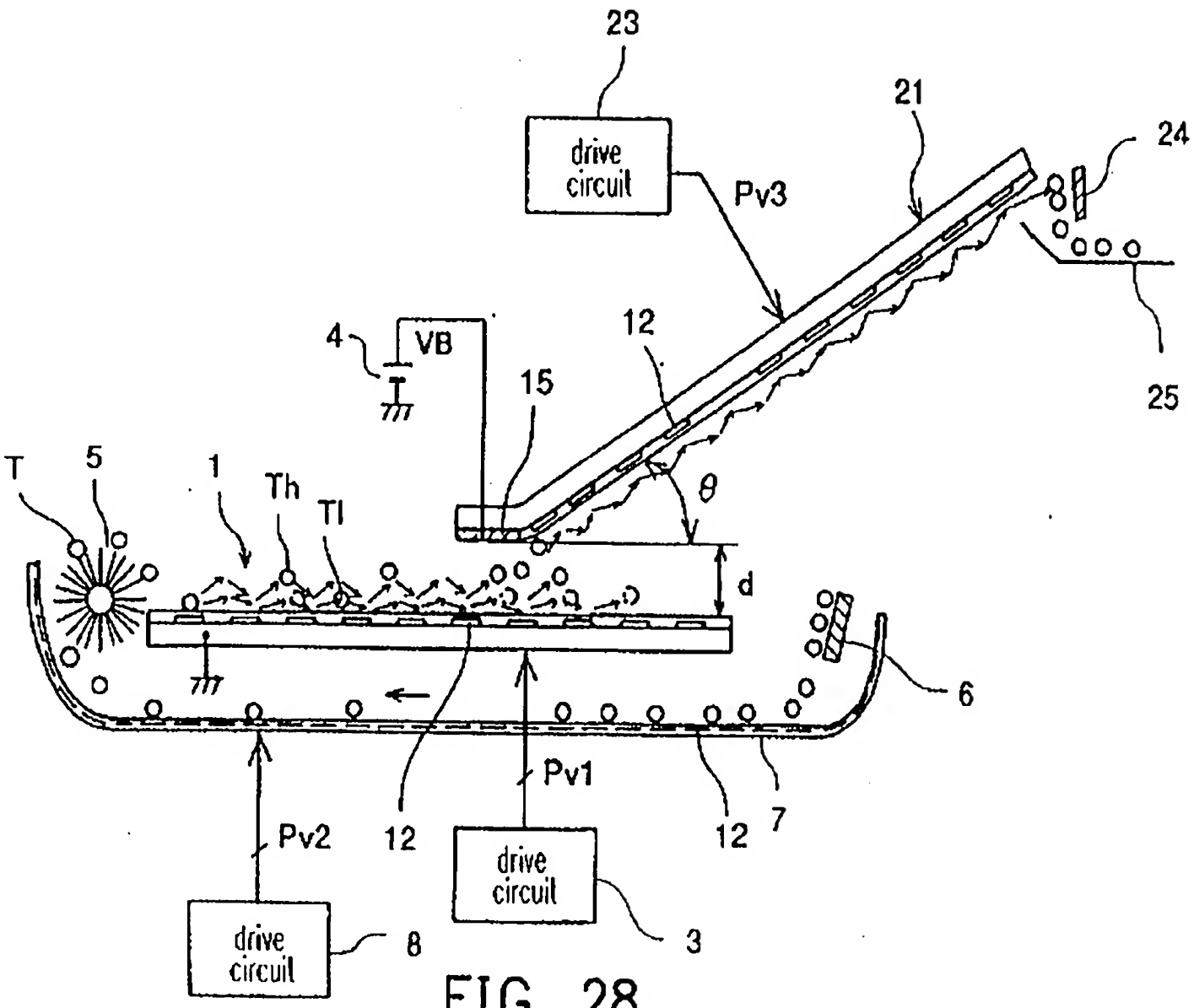

23
drive circuit
Pv3
21
24
25
4
VB
12
15
T
5
1
Th
Tl
θ
d
6
Pv1
Pv2
12
12
7
drive circuit
3
drive circuit
8

FIG. 28

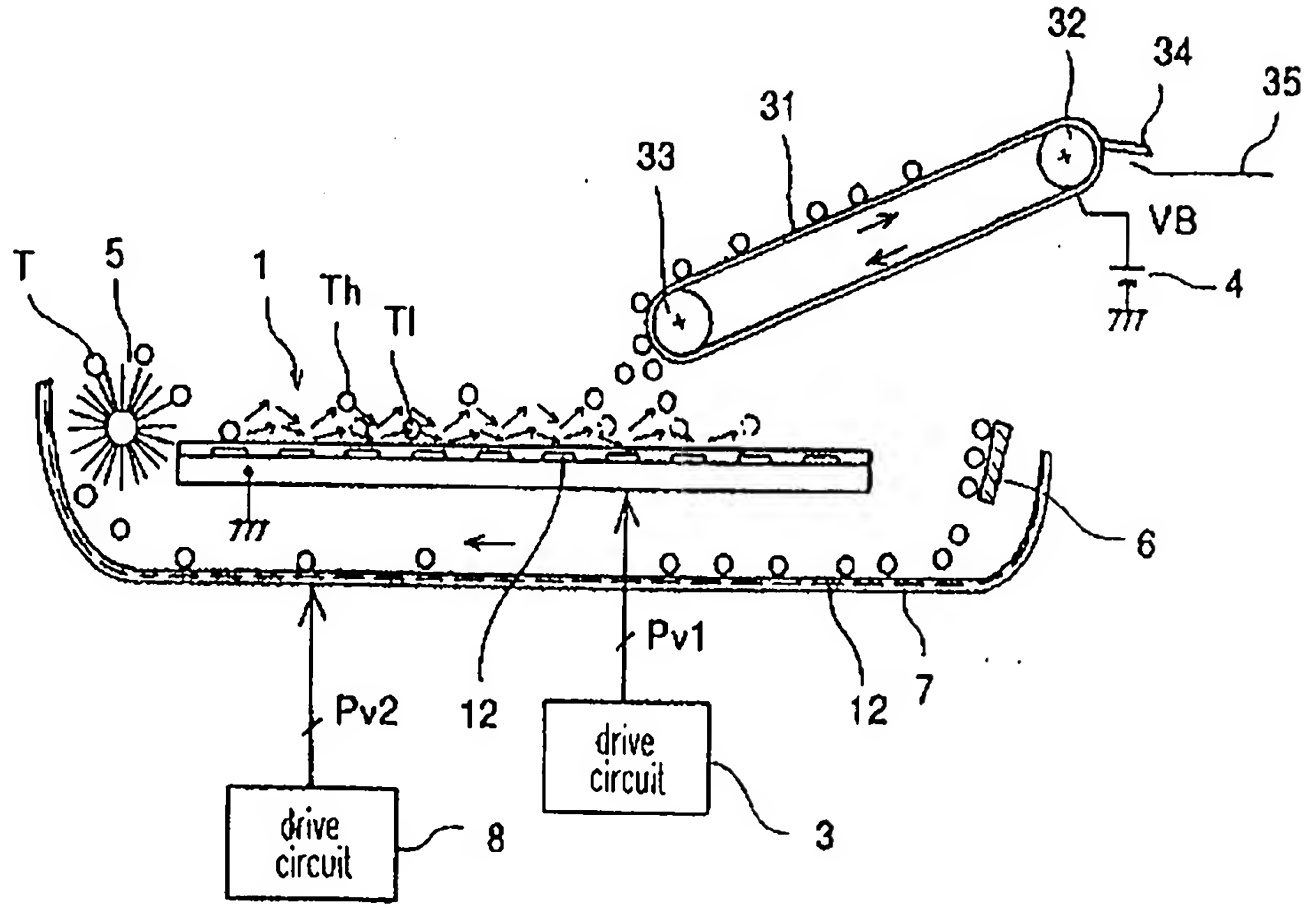

32
34
35
31
33
VB
4
T
5
1
Th
Tl
6
Pv1
Pv2
12
12
7
drive circuit
drive circuit
8
3

FIG. 29

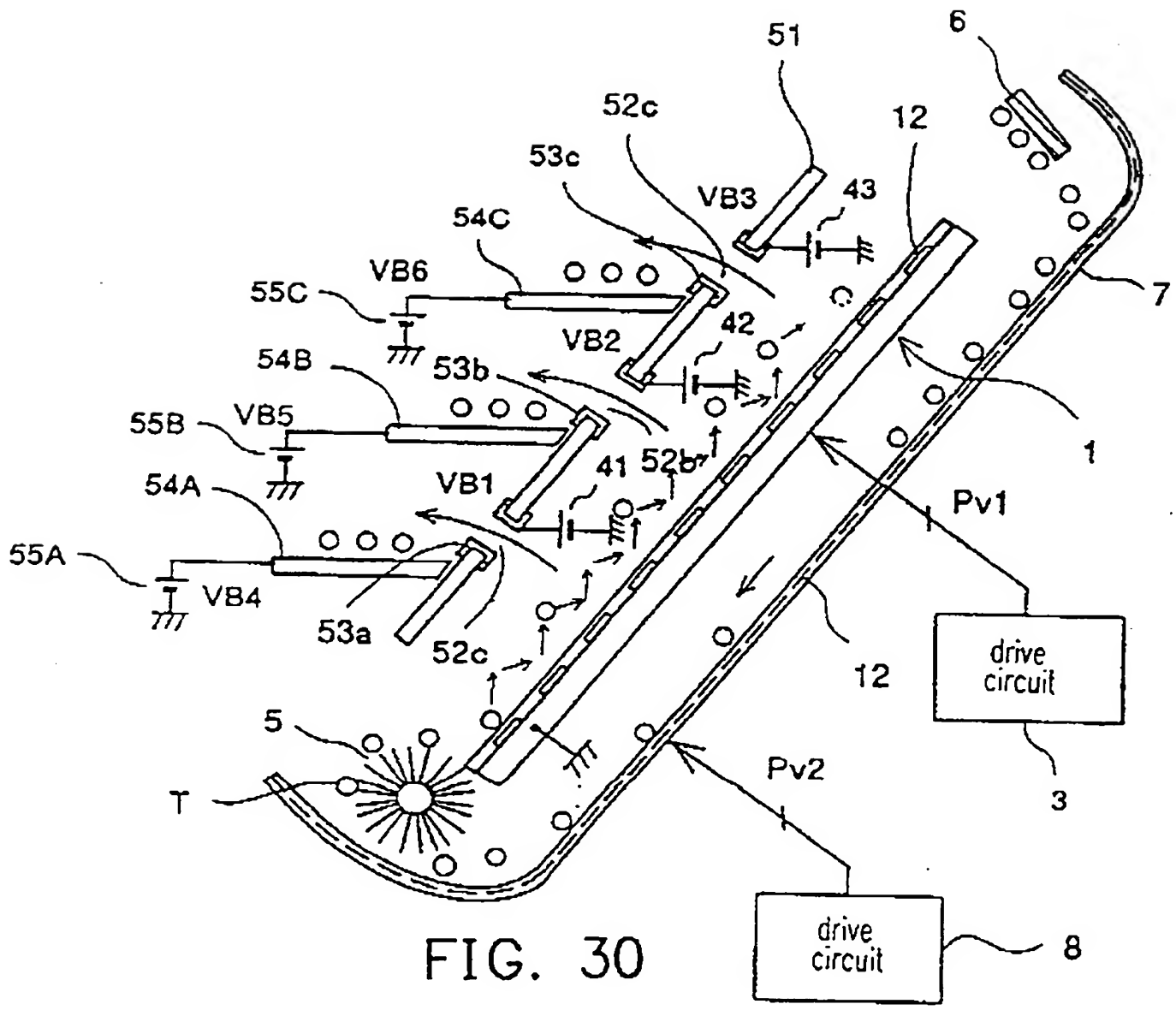

51
6
52c
12
53c
VB3
43
54C
VB6
55C
7
42
VB2
54B
53b
55B
VB5
52b
41
1
54A
VB1
Pv1
55A
VB4
53a
52c
12
drive circuit
5
Pv2
T
3
drive circuit
8

FIG. 30

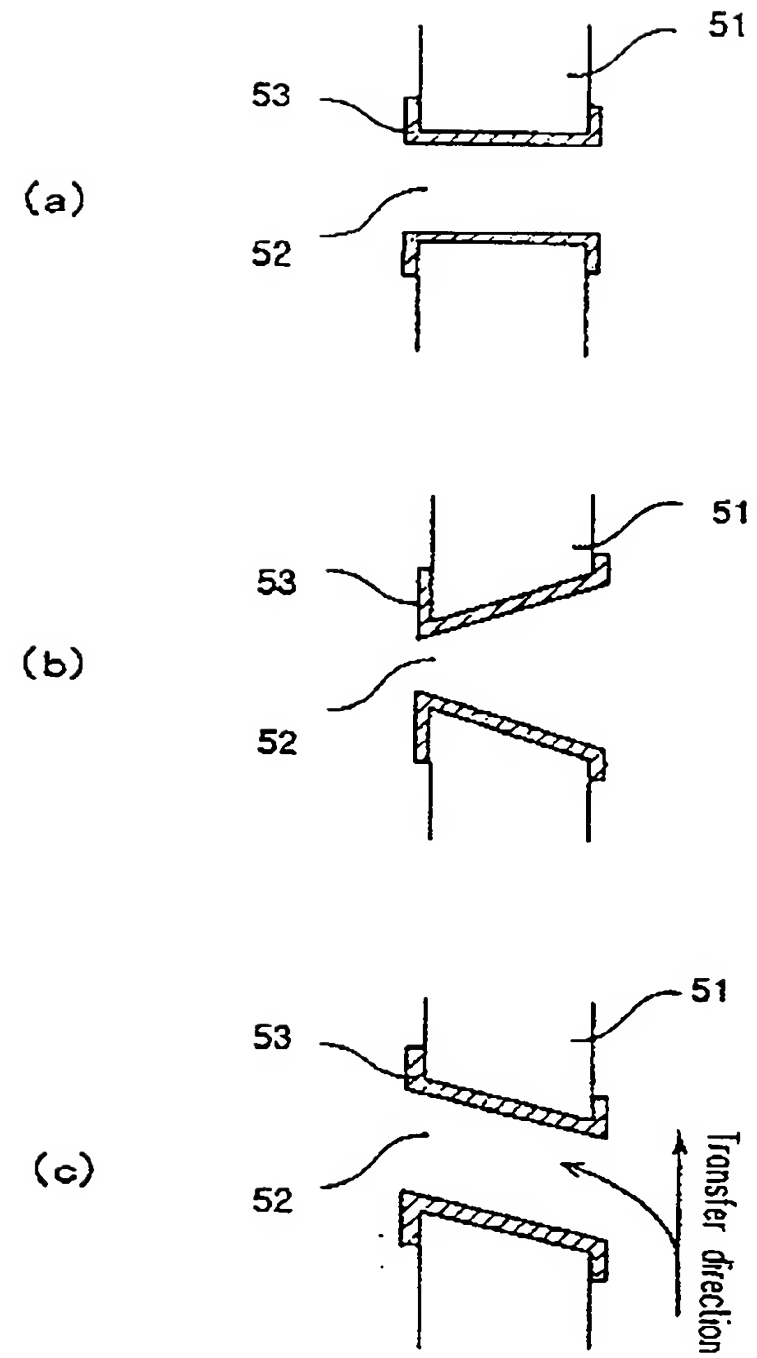


FIG. 31

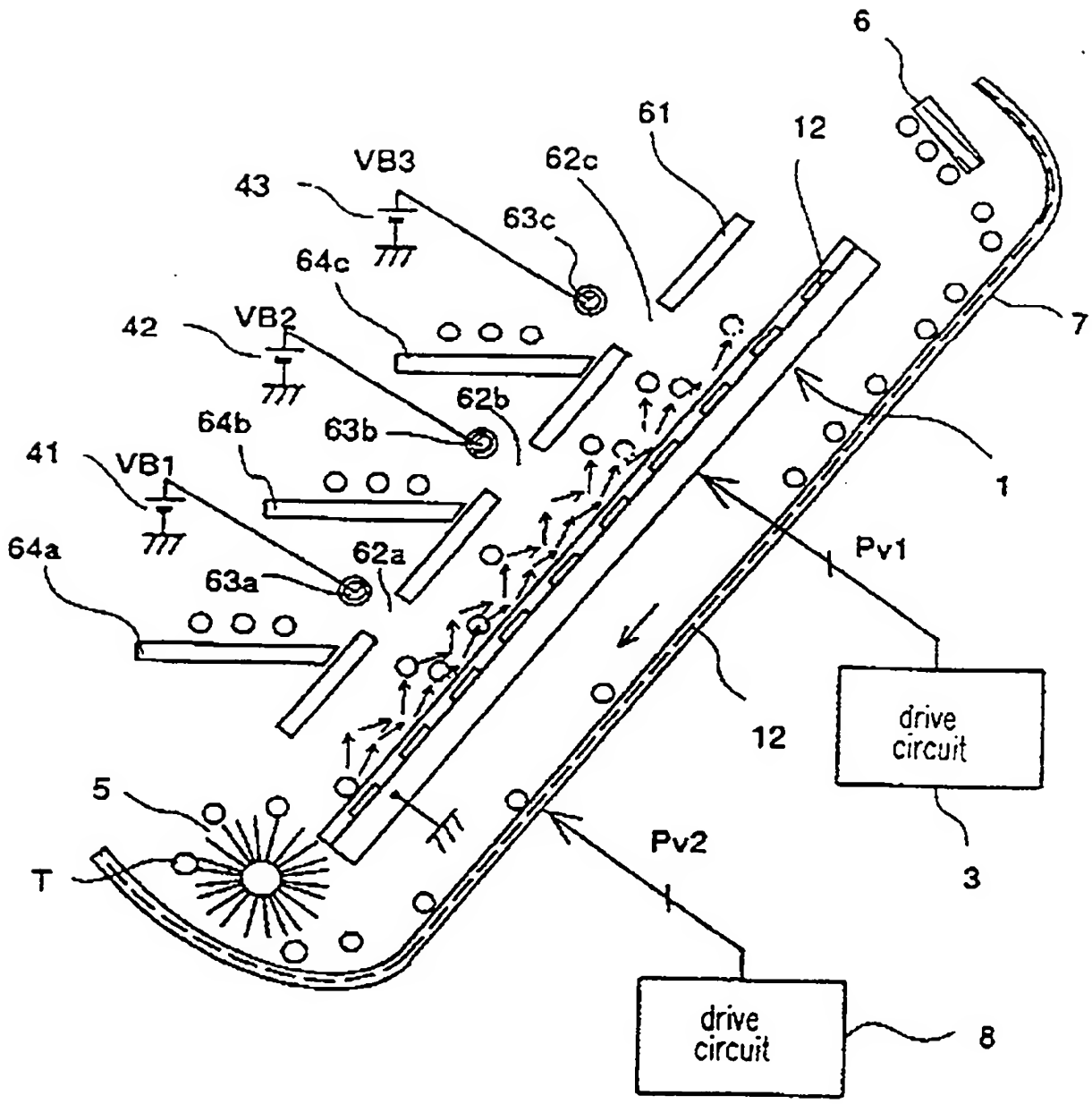

6
61
12
VB3
62c
43
63c
64c
7
42
VB2
62b
64b
63b
41
VB1
1
64a
62a
63a
Pv1
12
drive
circuit
5
Pv2
3
T
drive
circuit
8

FIG. 32

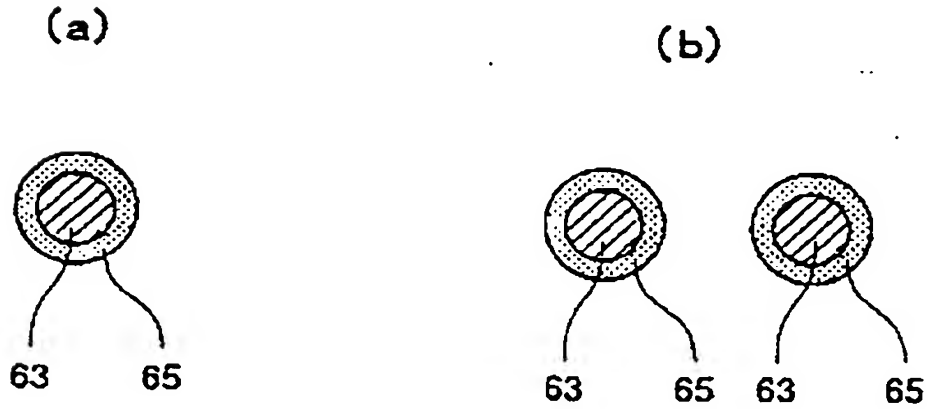

(a)
(b)
63
65
63
65
63
65

FIG. 33

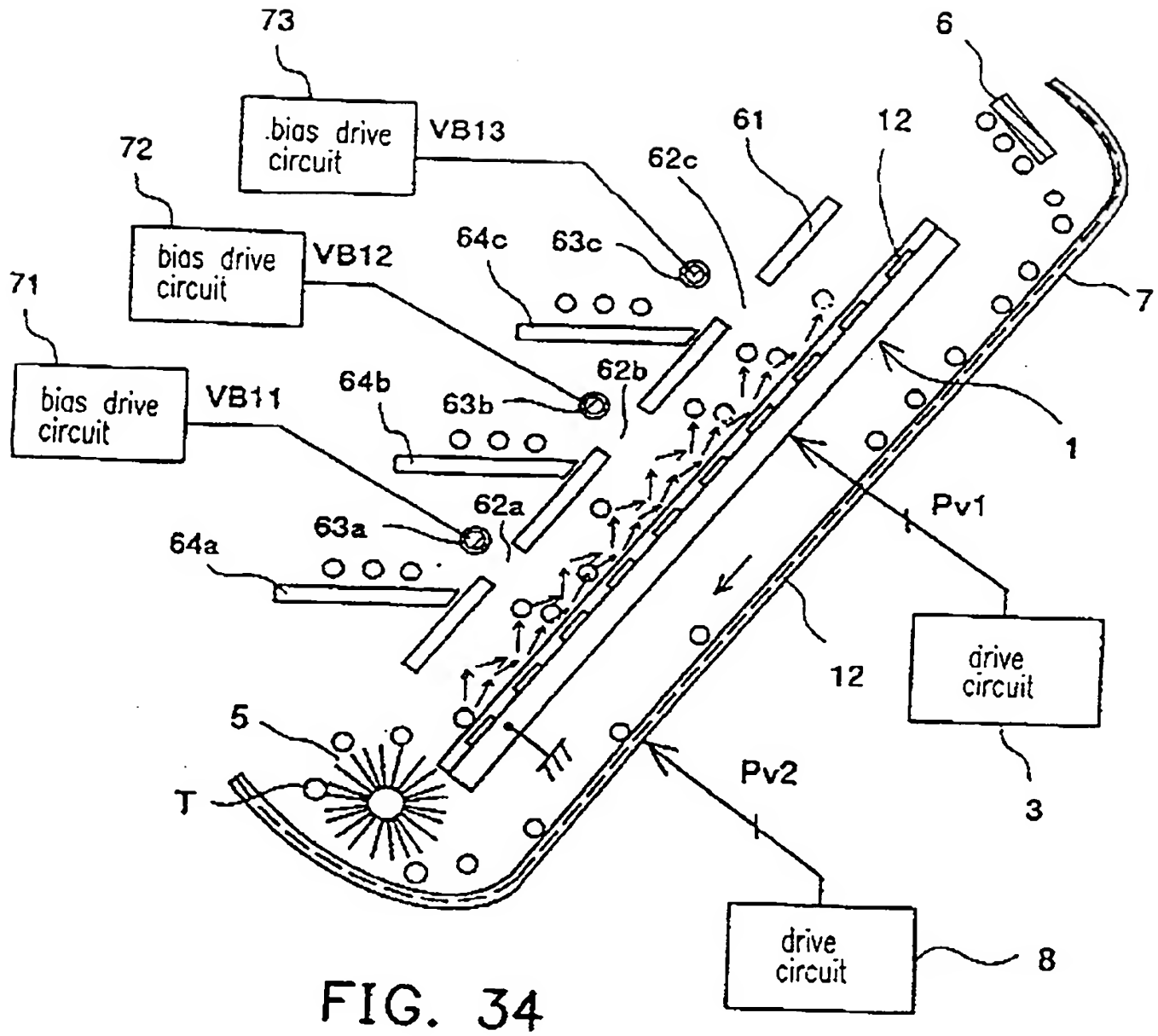

73
bias drive circuit
VB13
72
bias drive circuit
VB12
71
bias drive circuit
VB11
64c
63c
62c
61
12
6
7
64b
63b
62b
1
62a
63a
64a
Pv1
drive circuit
12
3
5
T
Pv2
drive circuit
8

FIG. 34

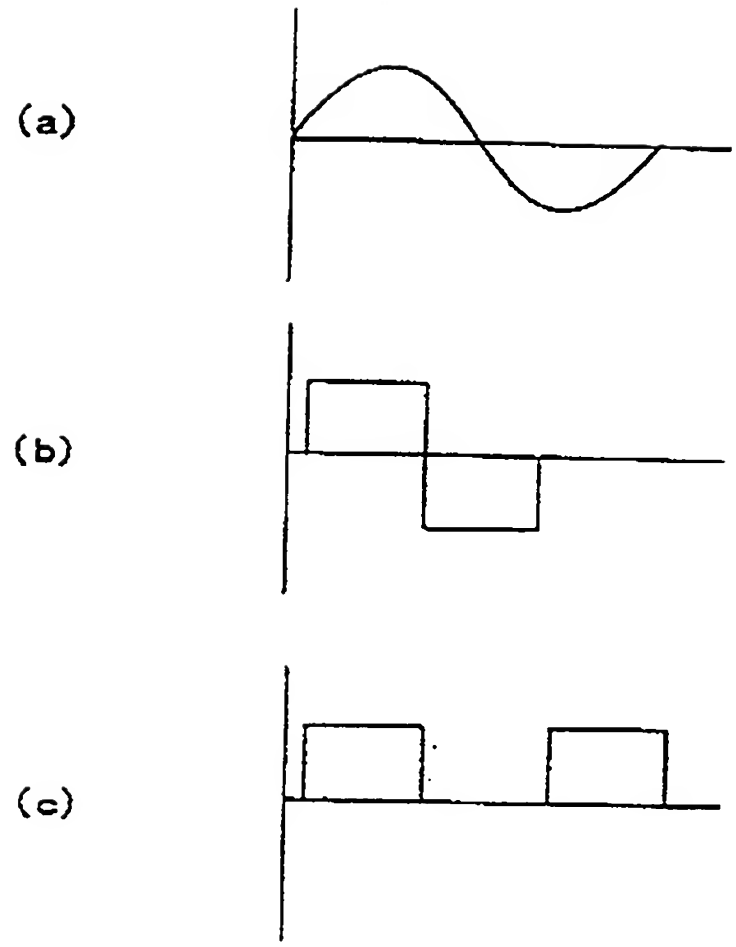


FIG. 35

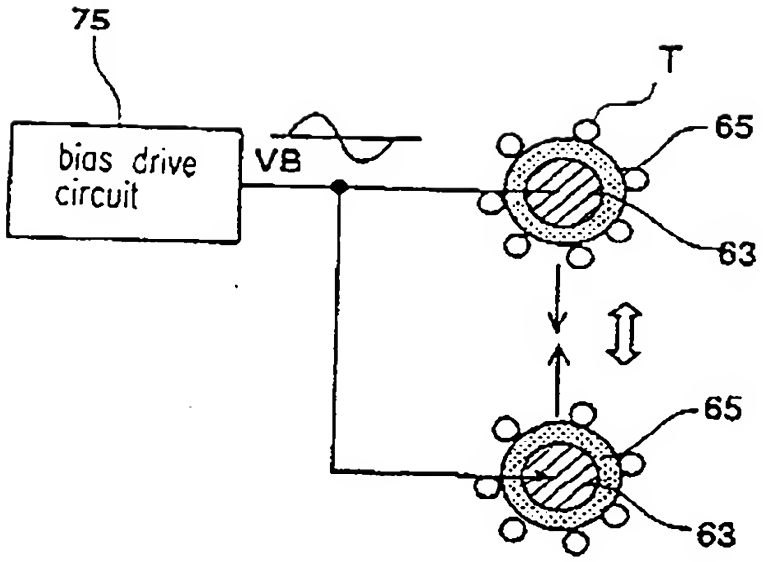

75
bias drive circuit
VB
T
65
63
65
63

FIG. 36

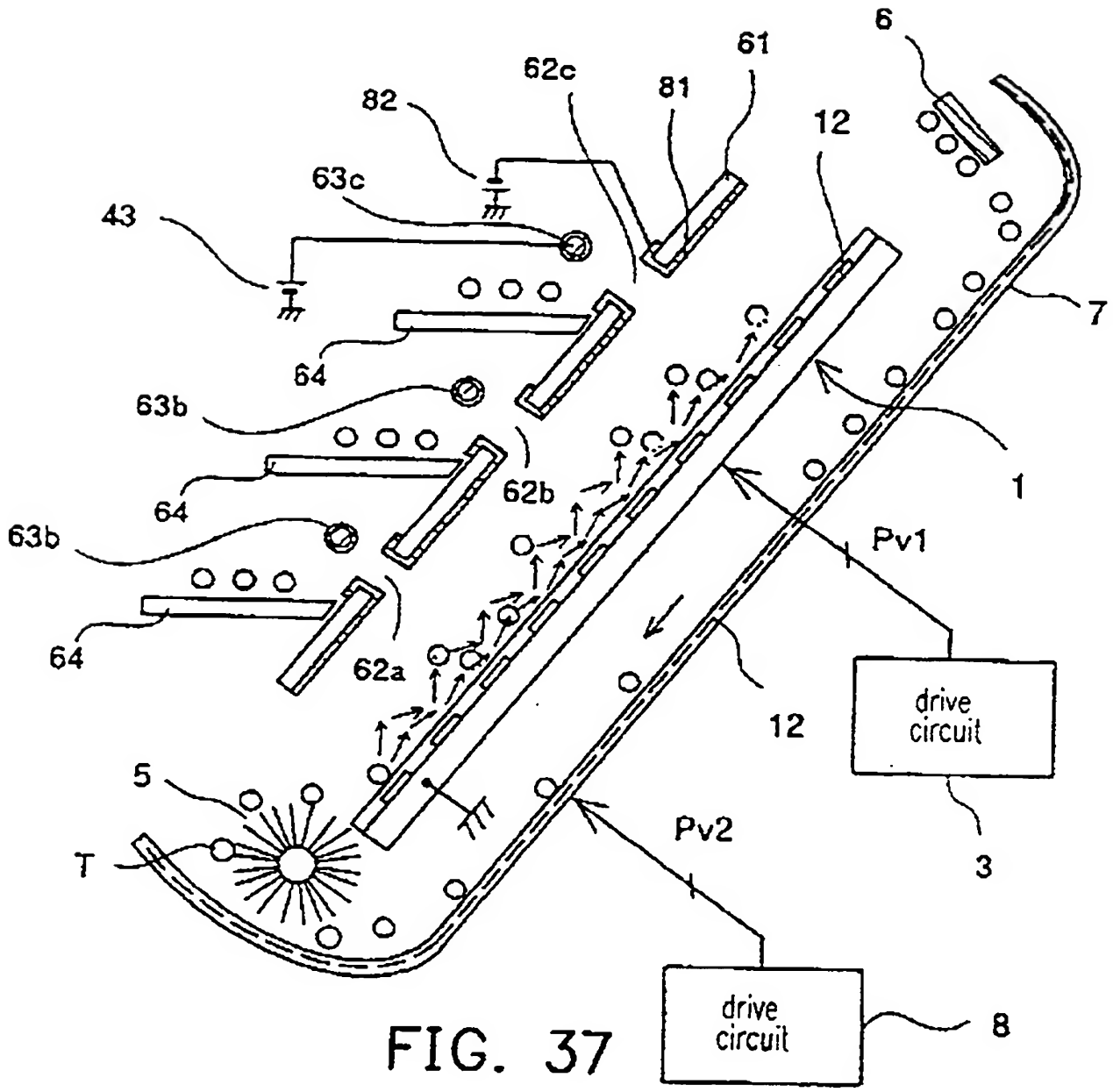

6
61
62c
81
82
12
63c
43
7
64
63b
1
62b
64
Pv1
63b
64
62a
12
drive circuit
5
Pv2
T
3
drive circuit
8

FIG. 37

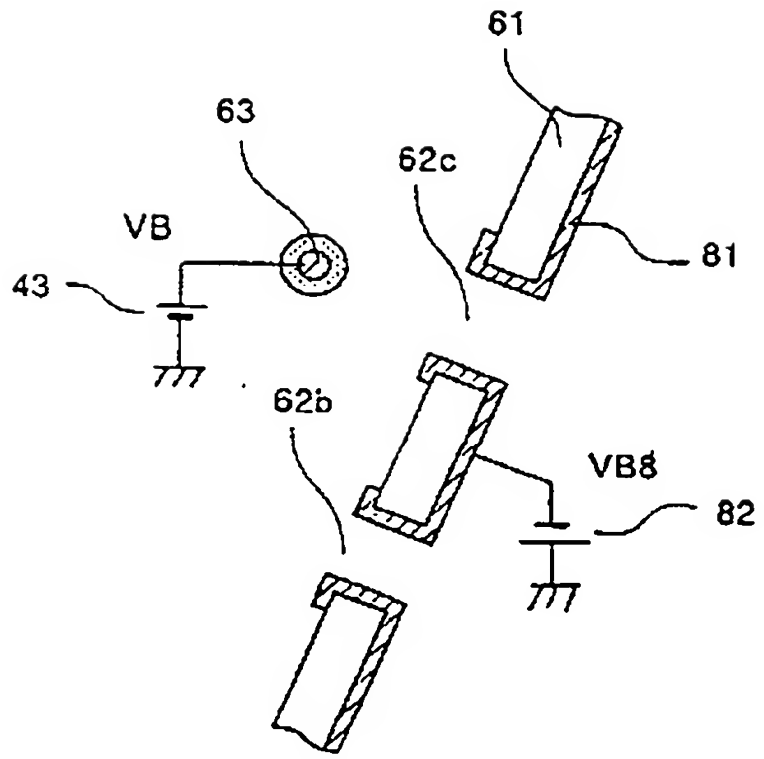

61
63
62c
VB
81
43
62b
VB8
82

FIG. 38

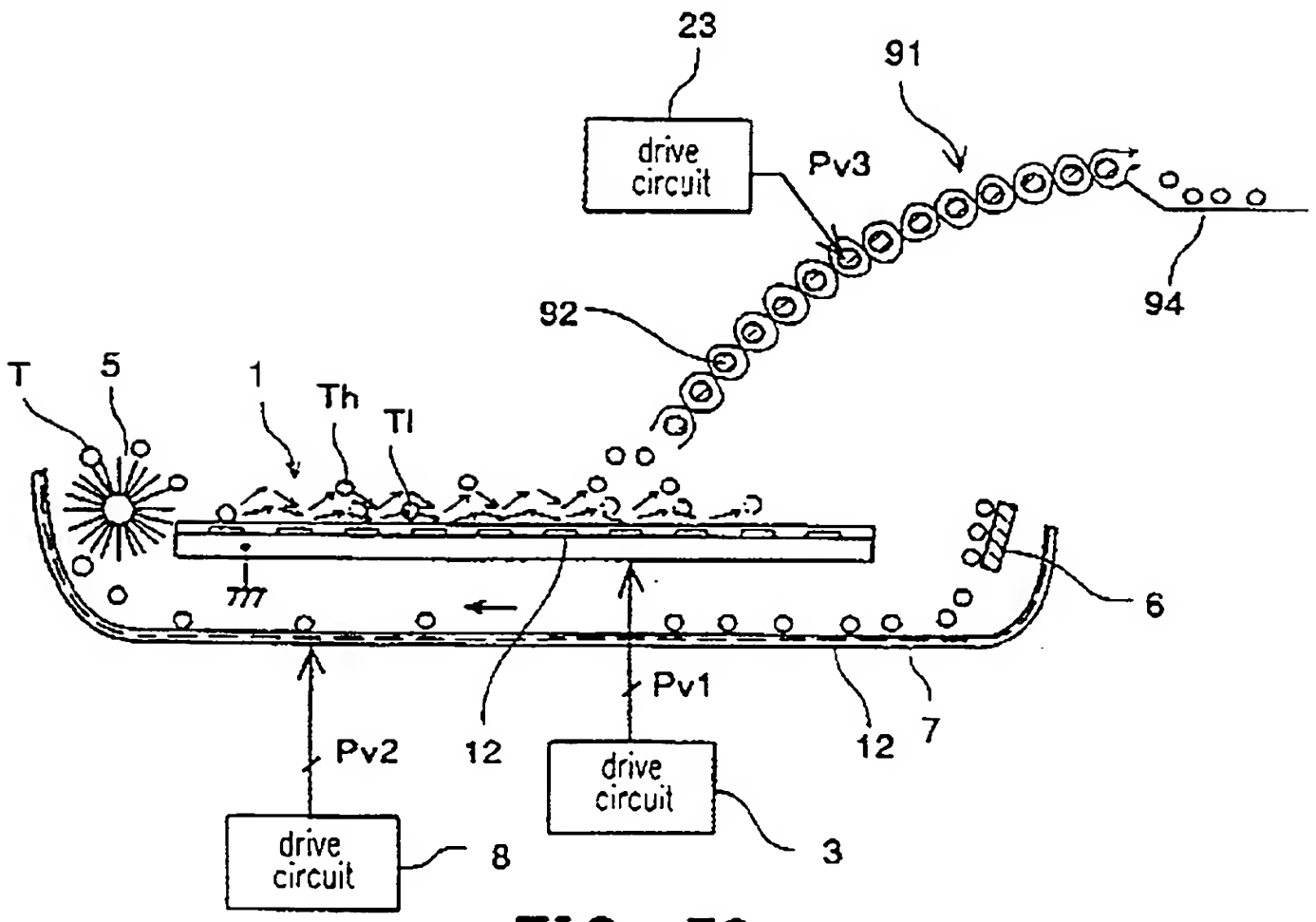

23
91
drive circuit
Pv3
94
92
T
5
1
Th
Tl
6
Pv1
Pv2
12
12
7
drive circuit
3
drive circuit
8

FIG. 39

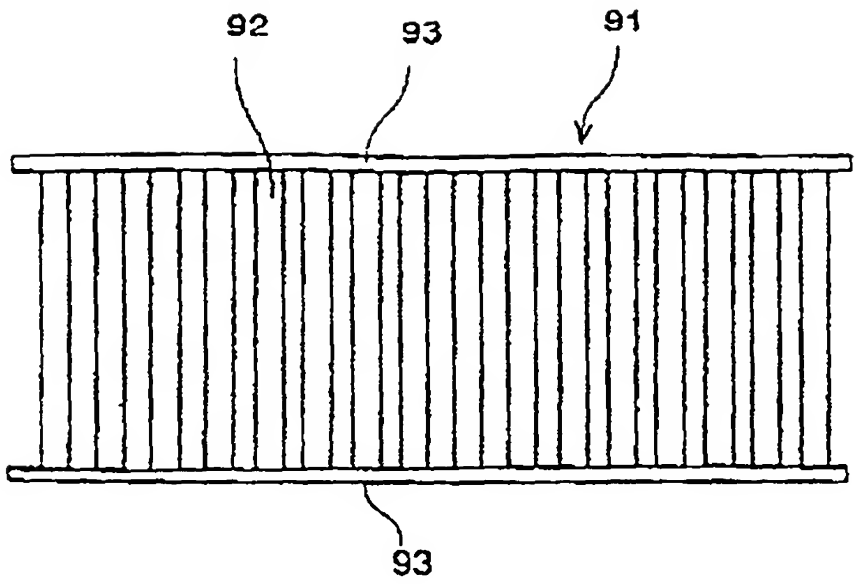

92
93
91
93

FIG. 40

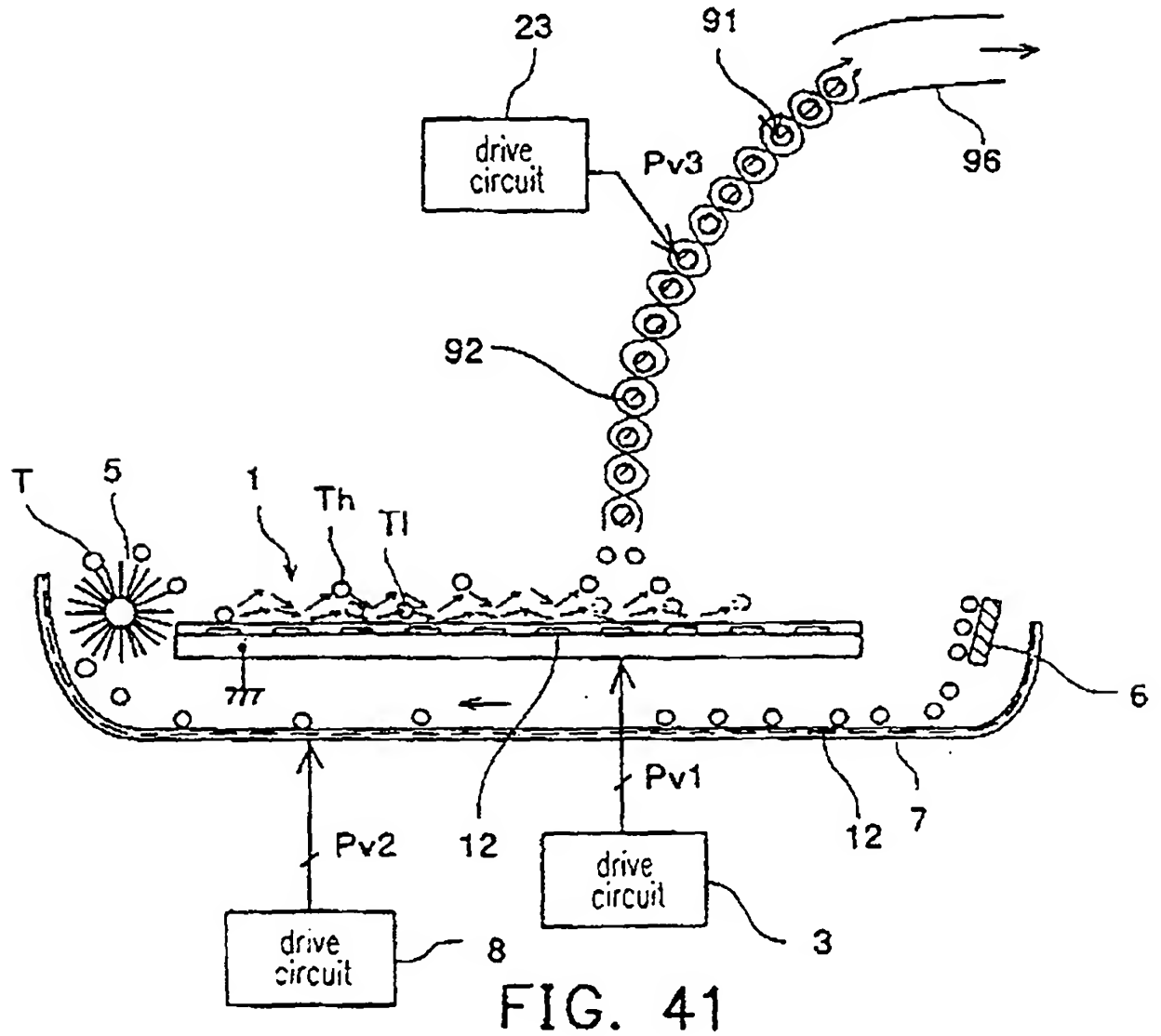

23
91
drive circuit
Pv3
96
92
T
5
1
Th
Tl
6
Pv1
Pv2
12
12
7
drive circuit
3
drive circuit
8

FIG. 41

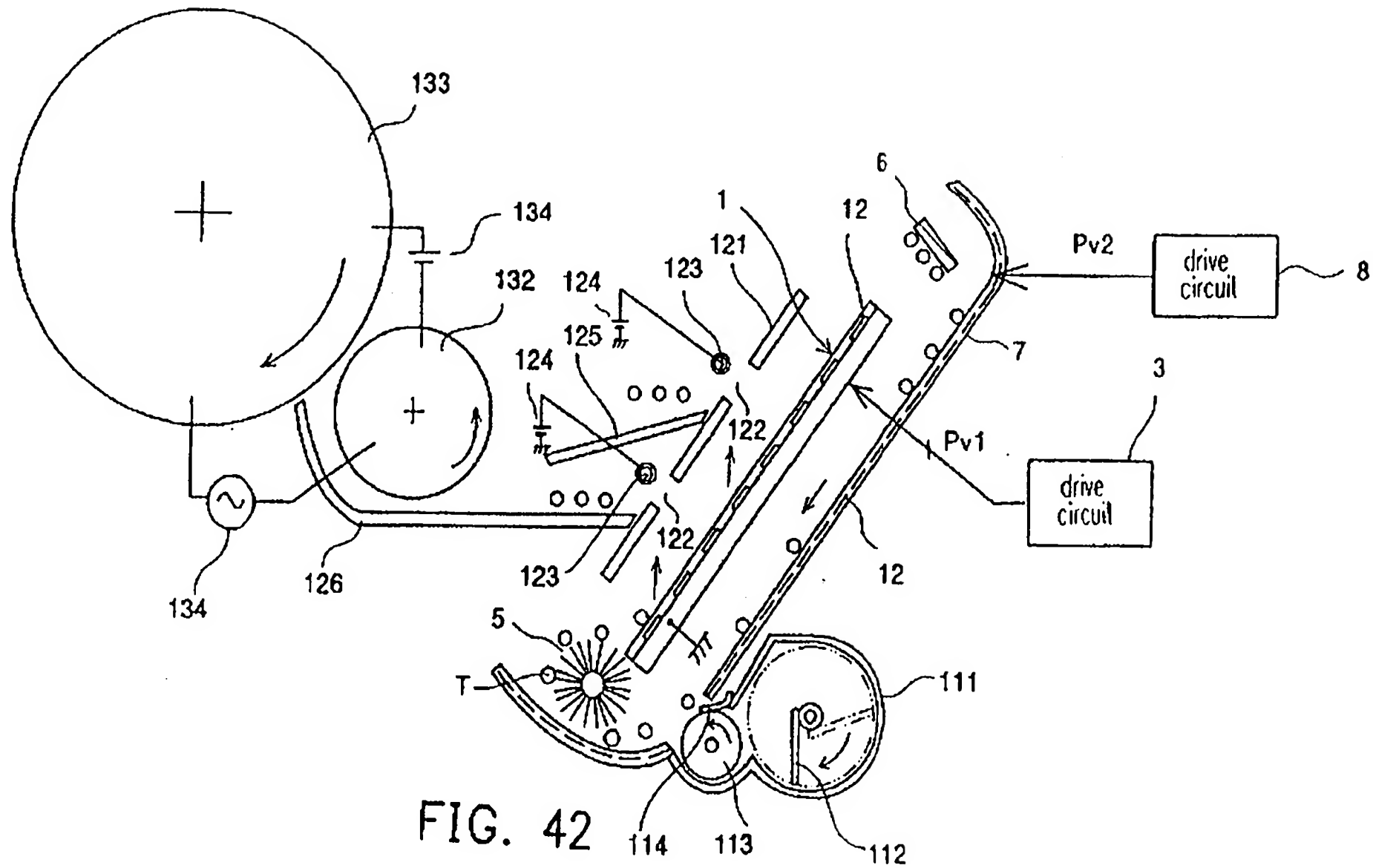

133
134
132
124
125
123
121
1
12
6
Pv2
drive circuit
8
7
3
124
122
Pv1
drive circuit
122
123
12
126
134
5
T
111
114
113
112

FIG. 42

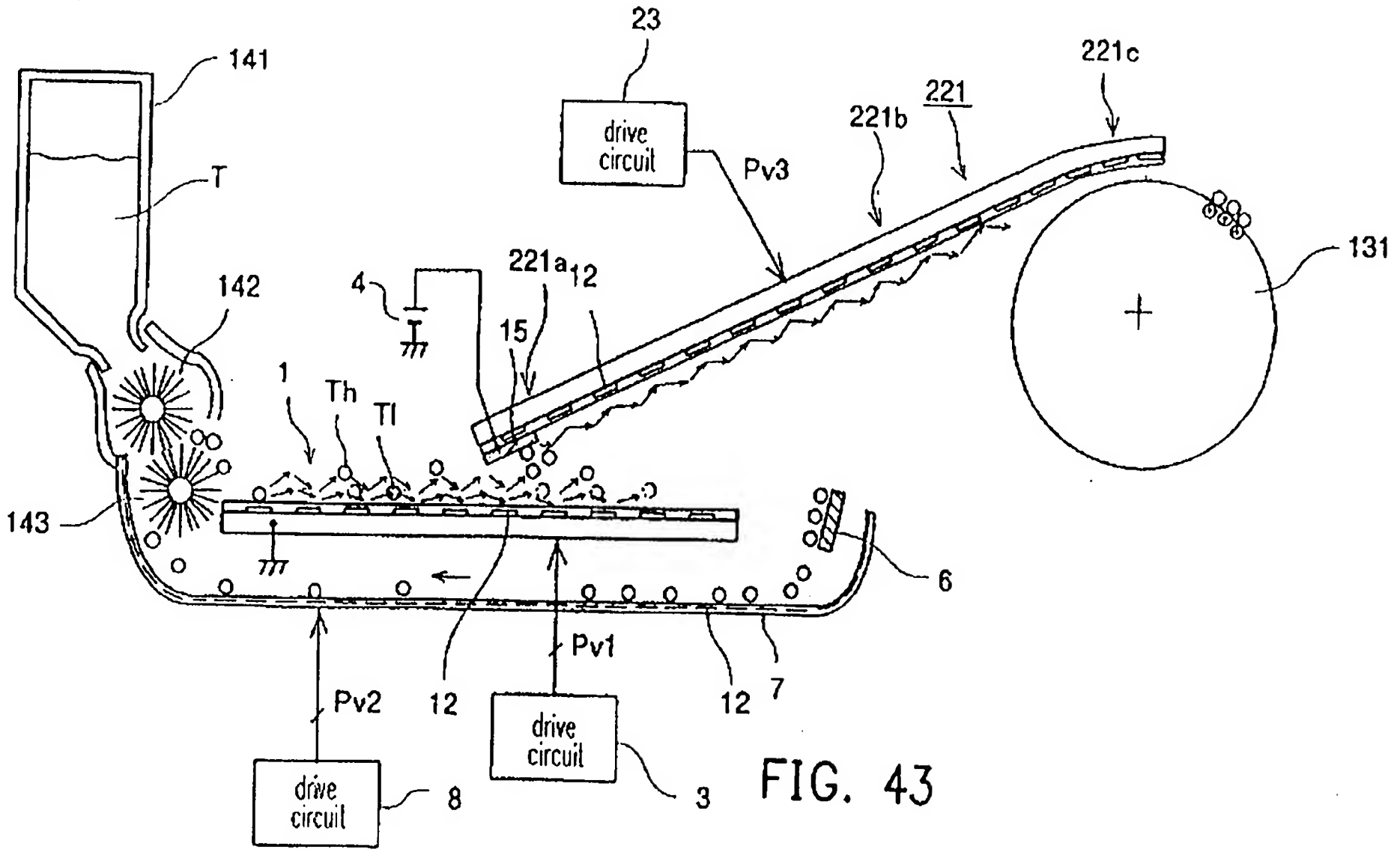

141
T
142
4
T
23
drive circuit
Pv3
221c
221
221b
221a
12
15
131
1
Th
Tl
143
6
Pv1
Pv2
12
12
7
drive circuit
drive circuit
8
3

FIG. 43

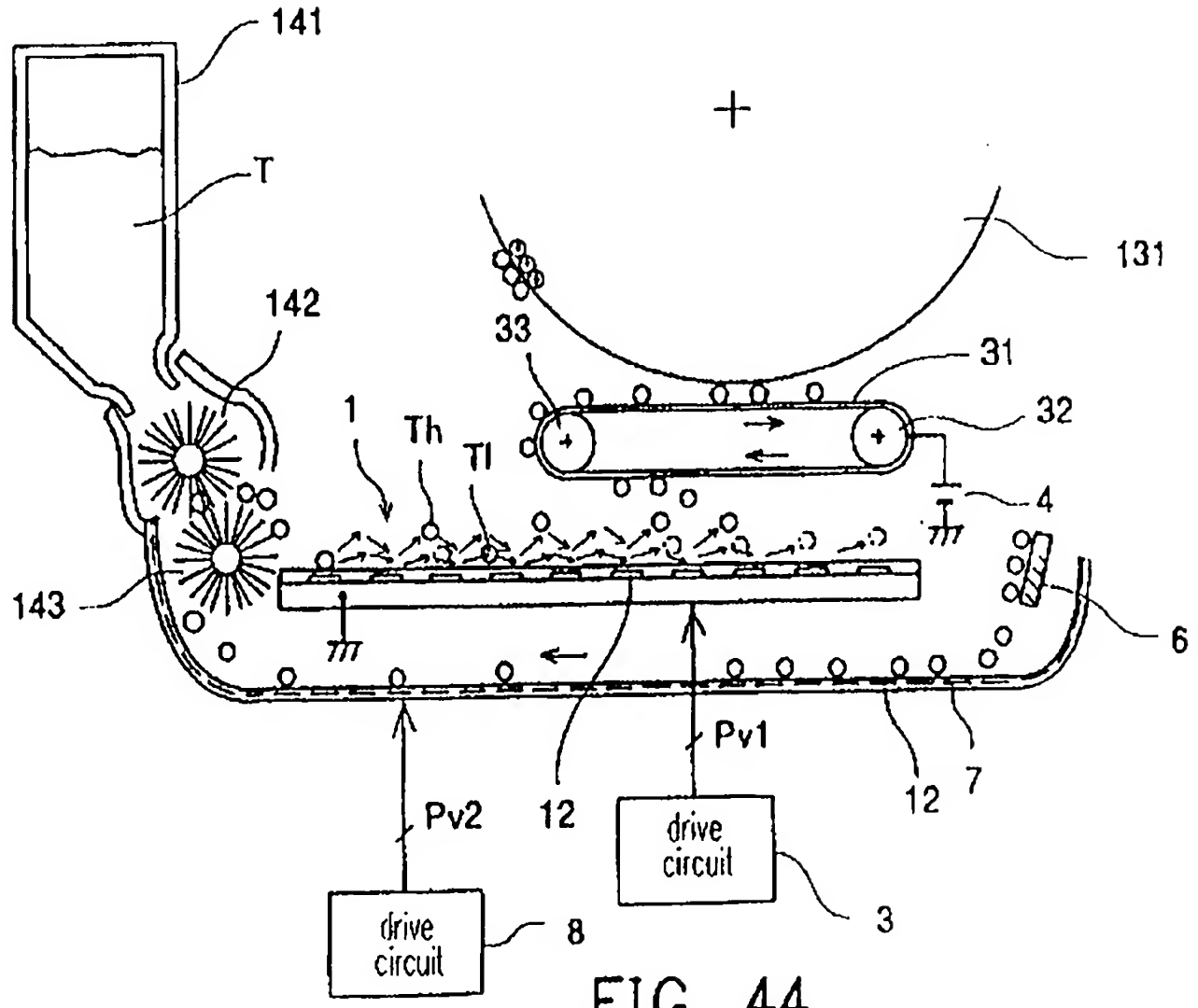

141
T
142
131
33
31
32
1
Th
Tl
4
143
6
Pv1
Pv2
12
12
7
drive circuit
3
drive circuit
8

FIG. 44

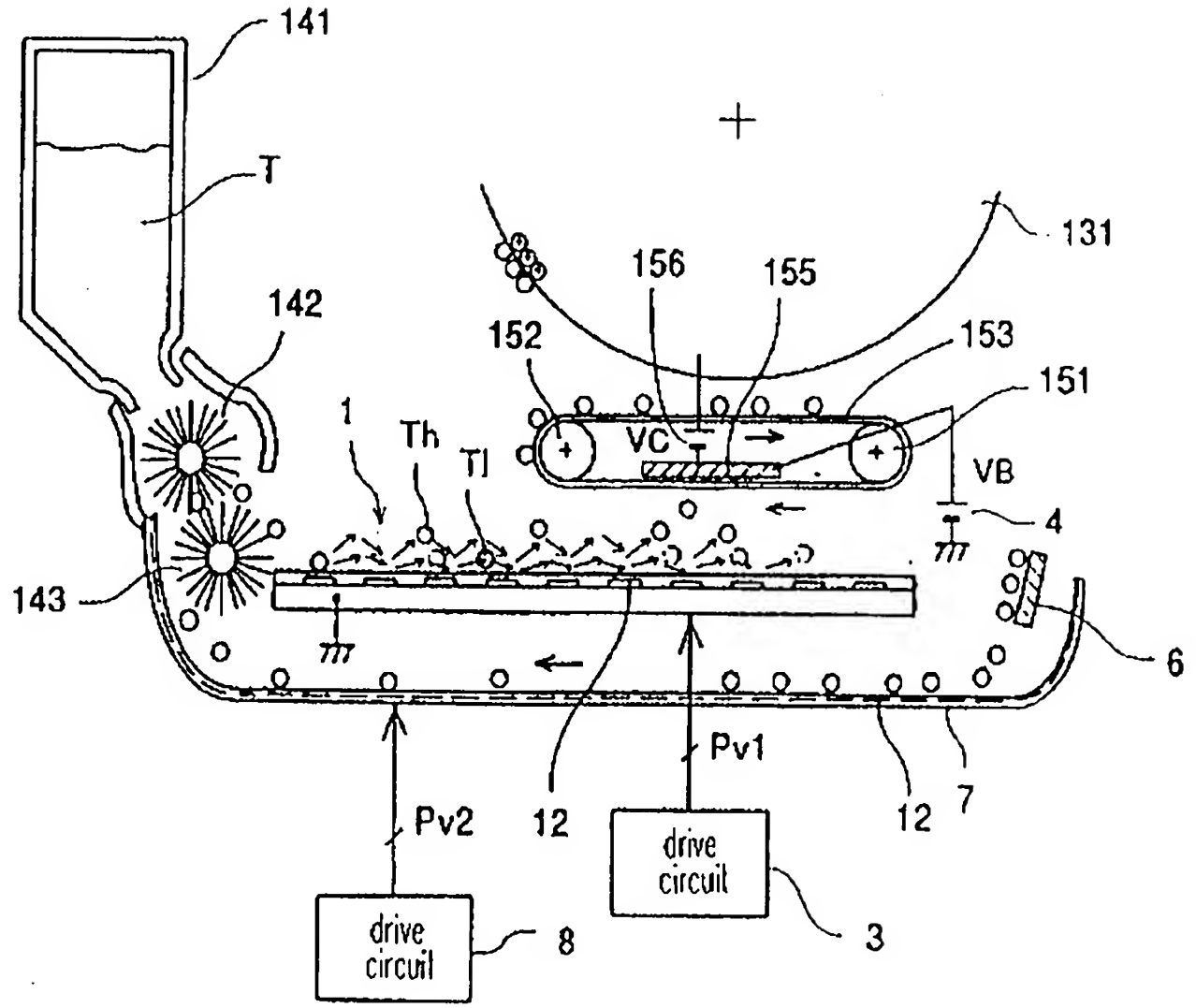

141
T
142
143
1
Th
Tl
156
155
131
152
153
151
VC
VB
4
6
Pv1
Pv2
12
12
7
drive circuit
drive circuit
8
3

FIG. 45

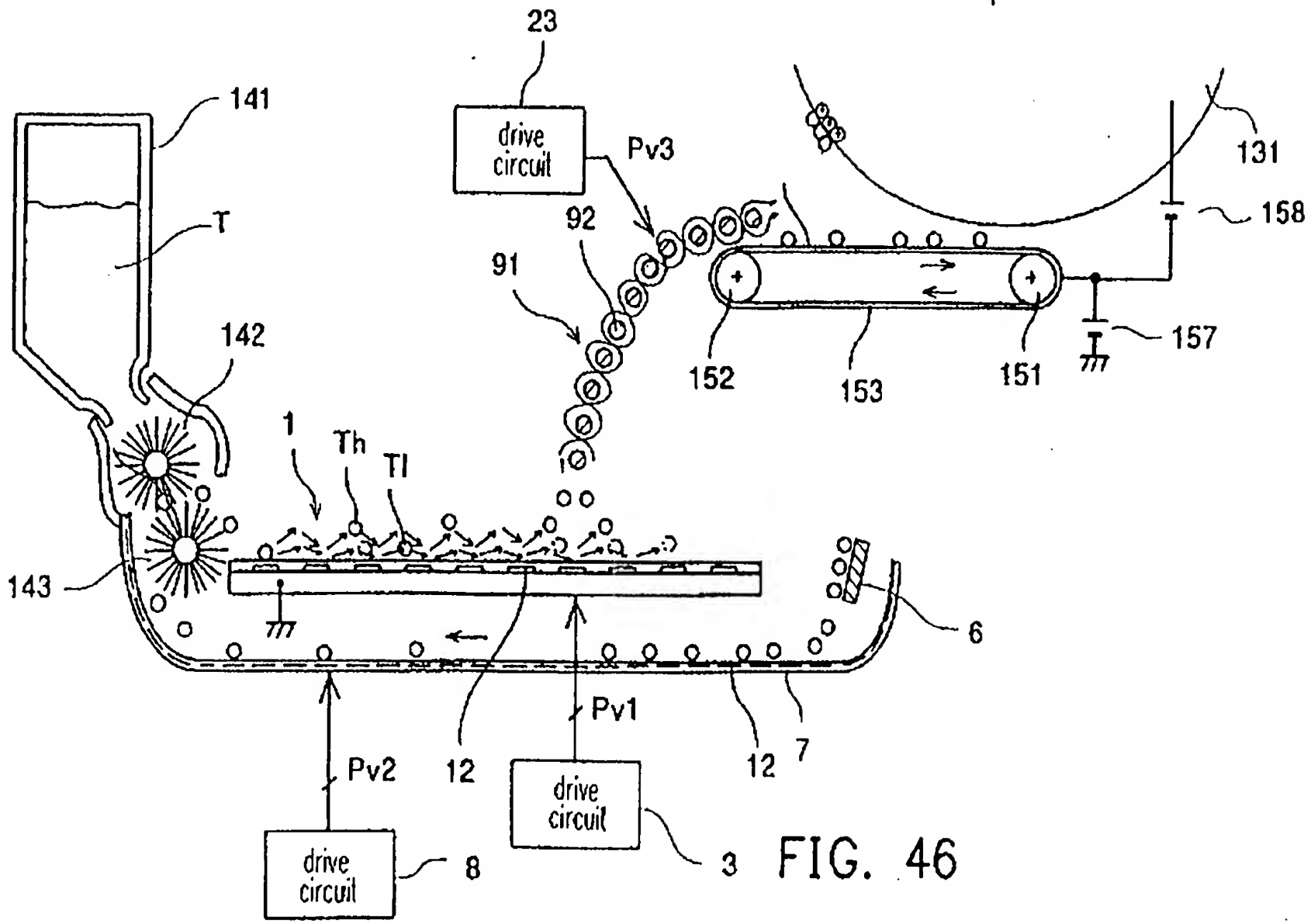

141
T
142
143
1
Th
Tl
23
drive circuit
Pv3
92
91
152
153
151
131
158
157
6
Pv1
Pv2
12
12
7
drive circuit
drive circuit
8
3

FIG. 46

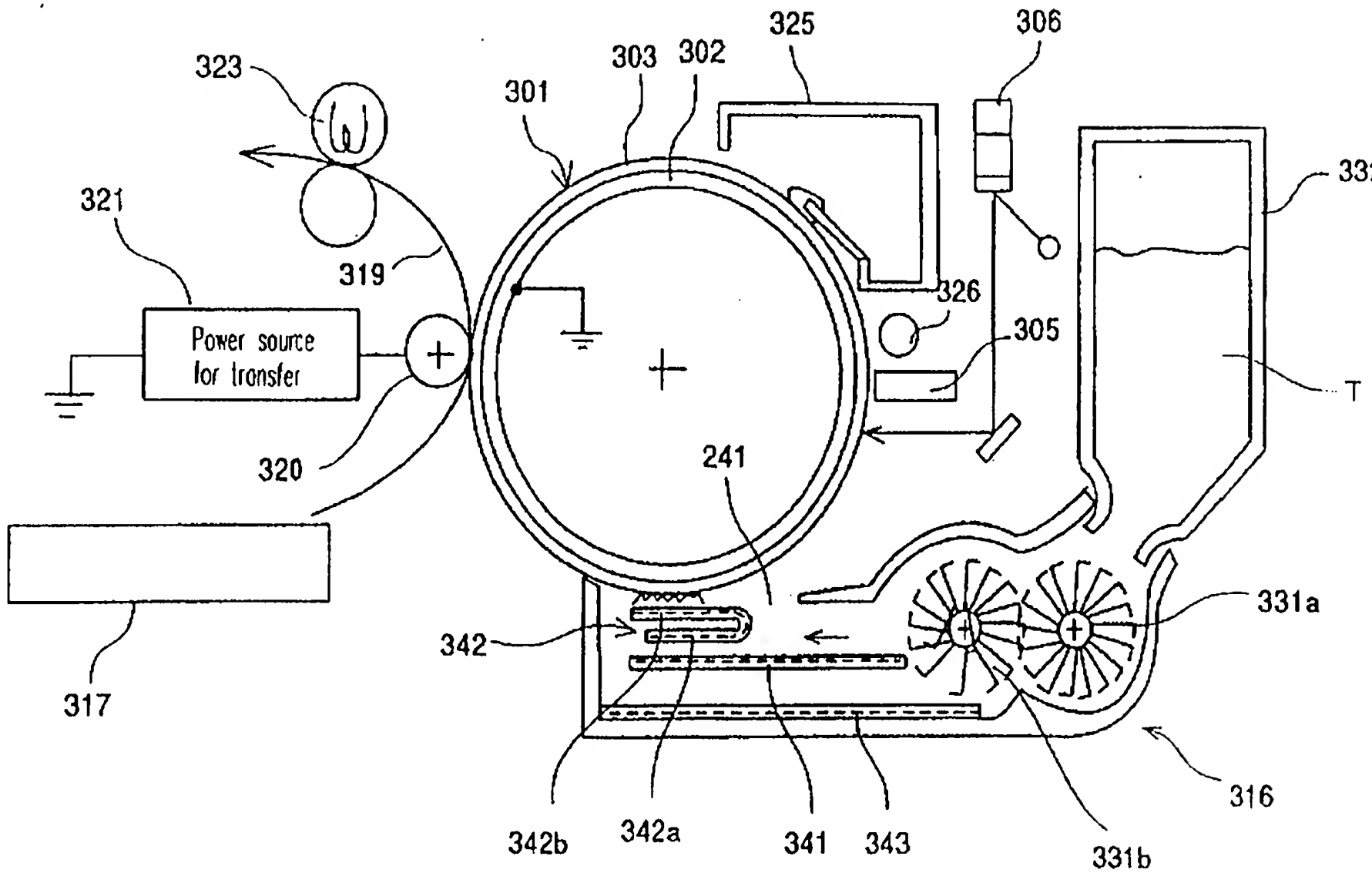

323
321
319
Power source for transfer
320
317
301
303
302
325
306
326
305
332
T
241
331a
342
342b
342a
341
343
331b
316

FIG. 47

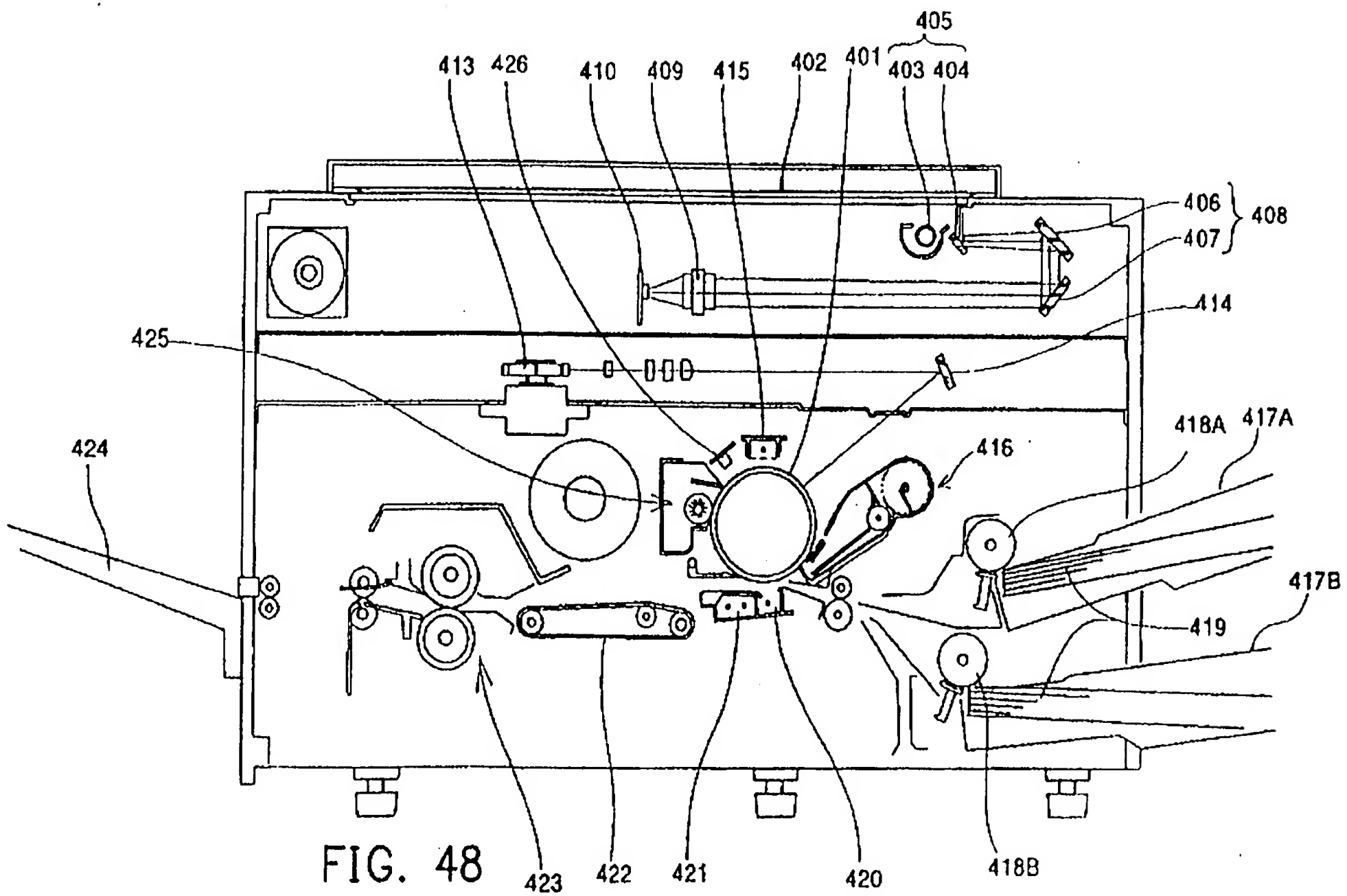

405
413
426
410
409
415
402
401
403
404
406
407
408
414
425
418A
417A
424
416
417B
419
423
422
421
420
418B

FIG. 48

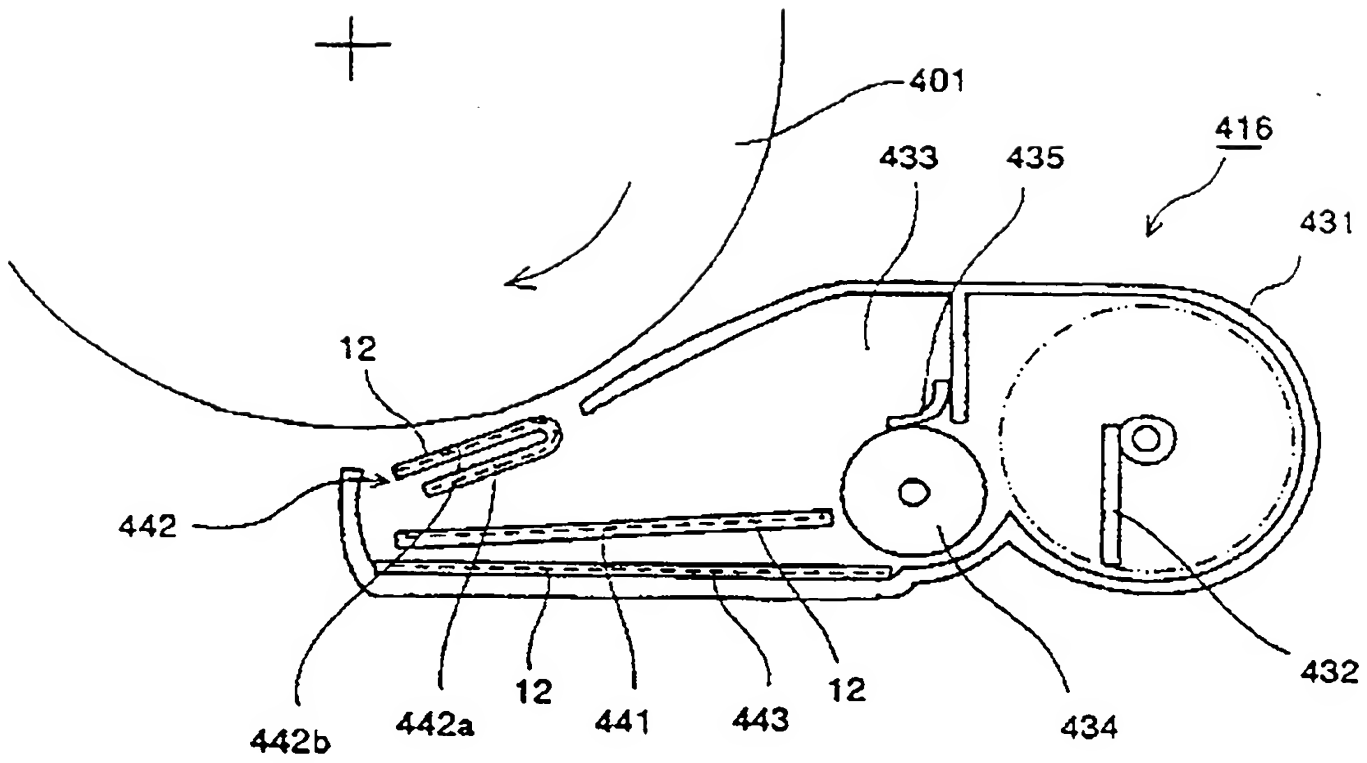

401
416
433
435
431
12
442
12
12
442b
442a
441
443
434
432

FIG. 49

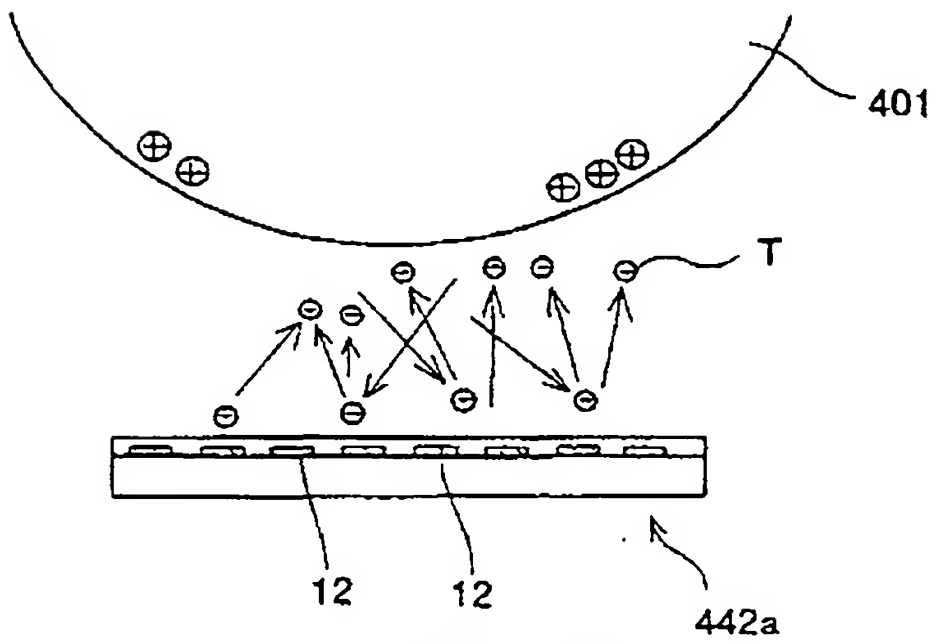

401
T
12
12
442a

FIG. 50

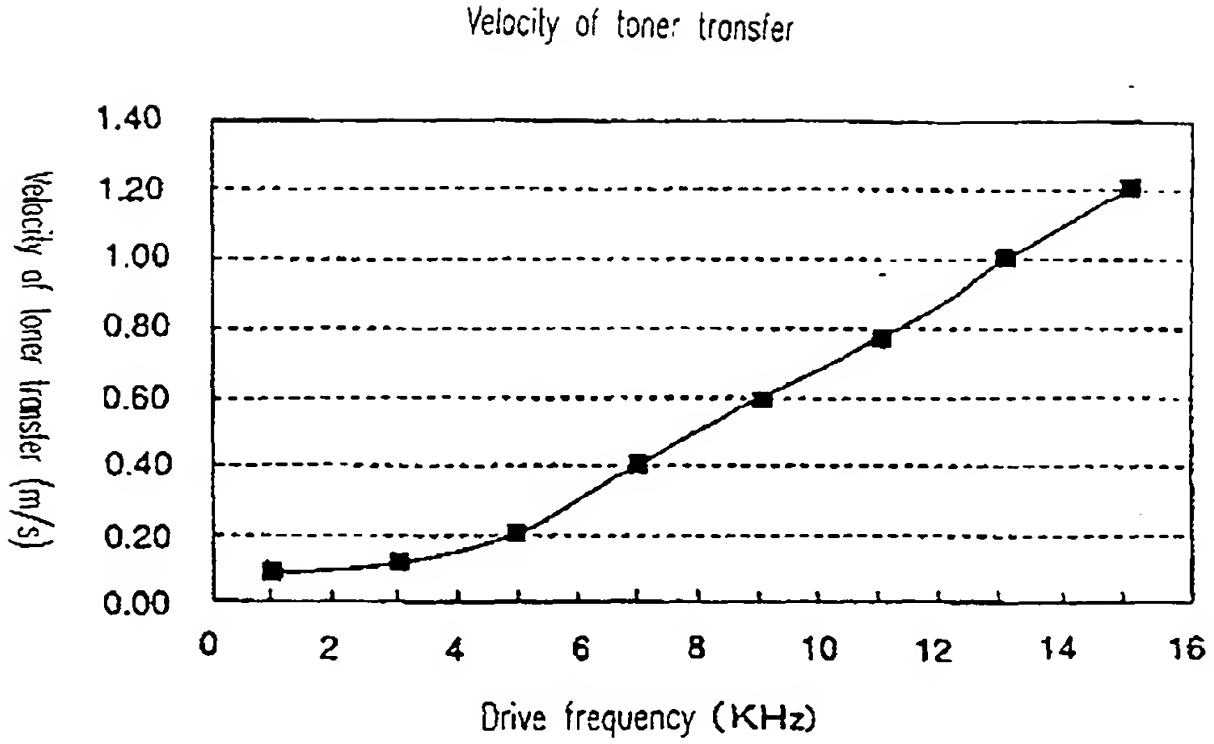

Velocity of toner transfer
Velocity of toner transfer (m/s)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
2
4
6
8
10
12
14
16
Drive frequency (KHz)

FIG. 51

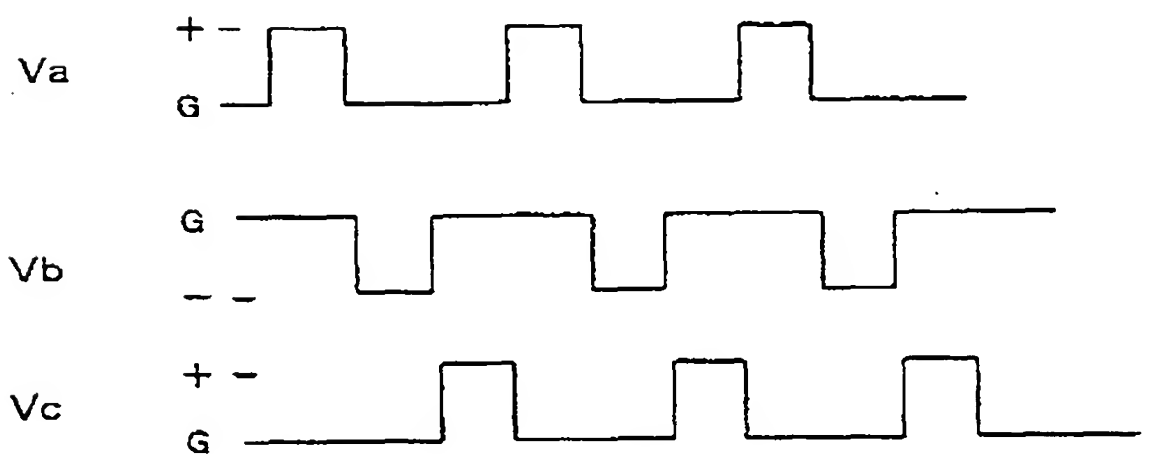

Va
+
-
G
Vb
G
-
-
Vc
+
-
G

FIG. 52

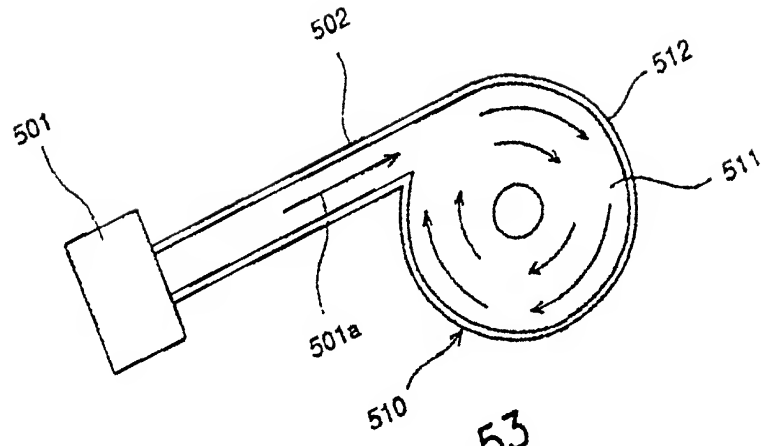

502
501
512
511
501a
510

FIG. 53

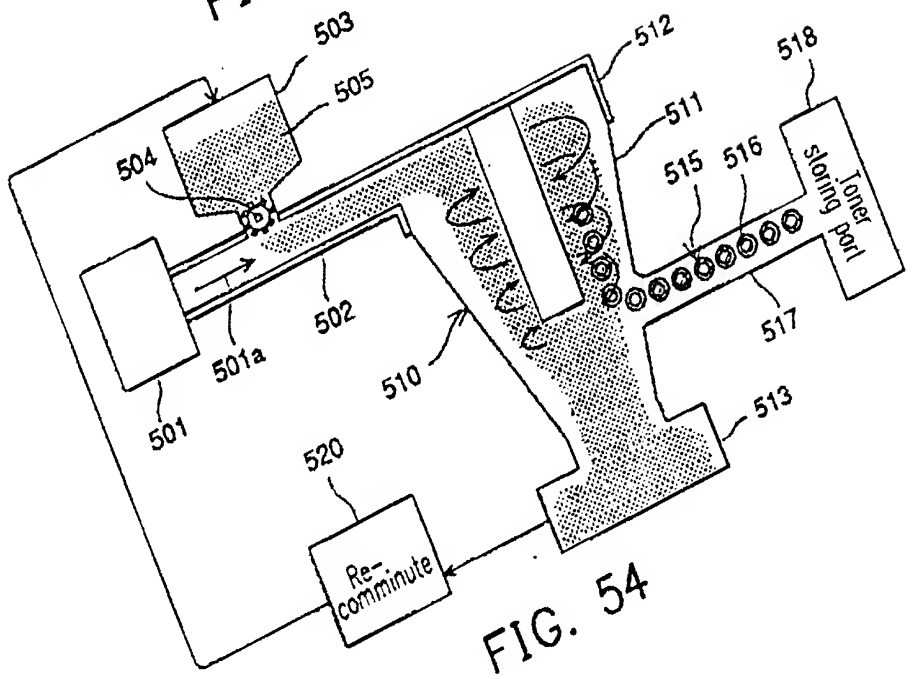

503
505
504
512
511
518
515
516
Toner storing part
502
501a
510
517
501
513
520
Re-comminute

FIG. 54